Investigation of Creep of Metals and Alloys. 6. Diffusion Creep of Binary Substitutional Solid Solutions

carried out on wire specimens (0.5, 0.6 and 0.2 - 0.3 mm diameter for Cu-Ni, Au-Ni and Pb-Sn alloys, respectively), the loads applied in the case of Cu-Ni alloys being 4.6 by 10^6 dynes/cm^2 at 1000 and 900°C, and 12.2 x 10^6 dynes/cm^2 at 800°C. To prevent the difference in the grain size of various test pieces affecting the data on activation energy, the measurements at various temperatures were taken on one and the same test piece; the first measurement at 1000°C, the next one at 900 and the last at 800°C. It was ensured, in this way, that the variation of η with temperature was associated only with the variation of ξD_b. To obtain reliable data on the magnitude of activation energy, the measurements were taken on specimens characterised by various initial grain size. To determine the magnitude θ values of η obtained from the creep curve in the steady creep region were used. The relationship $\ln\eta$ versus $1/T$ for the 50Au - 50Ni alloy is shown in Fig 7. The value of the activation energy determined from the slope of the curve in Fig 7 and equal approximately 45 x 10^3 cal/mol, is

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shown in Fig 2 as a full circle lying on the theoretical curve. The data on viscosity of the Sn-Pb system at 175 and 160°C are given in Table 3 (column 1 - composition Sn-Pb%; column 2 - T°C; column 3 - η (in poises)). These data are reproduced graphically in Fig 8. The experimental and calculated values of η (at 160 and 175°C) and θ (kcal/mol) for three Pb-Sn alloys are given in Table 4. Detailed analysis of the experimental results shows that the observed concentration dependencies of η and θ are satisfactorily described by Eq (10) and (5). It is shown also on the example of the Au-Ni system that the value of the activation energy in viscous flow can be determined by three independent methods: (a) from data on the coefficients of self-diffusion of the components of the solution; (b) from data on latent heats of fusion of the components of the solution and on the value of the difference of the displacement energy which can be found from the equilibrium diagram;(c) from data on the temperature dependence of the rate of viscous flow. In the last

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paragraph of the paper the author discusses the possibility of inter-crystalline adsorption during diffusion creep. It is stated that in every grain of a polycrystalline specimen subjected to a creep test one has to differentiate between two groups of grain boundaries and that the continuous flow of vacancies takes place from the boundaries of the type α on which the tensile forces are acting to the boundaries of the type β (see Fig 10, where the continuous, broken and dotted lines illustrate the flow of vacancies, atoms A and atoms B, respectively). At a given temperature the rate of flow of vacancies is a function of the load applied to the specimen. Atoms A and B move in the opposite direction since $\vec{J}_b = \vec{J}_A + \vec{J}_B$, where J_b, J_A and J_B are the flows of vacancies, atoms A and atoms B respectively. Since in a general case $D^s_A \neq D^s_B$, the rate of flow of atoms B will differ from that of the flow of atoms A. Consequently, this flow of atoms induced by externally applied loads results in change of

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concentration of atoms in the grain. If it is assumed that $D_A^s > D_B^s$, the grain boundaries of type α should become enriched in atoms in A and correspondingly, grain boundaries of the type β should become enriched in atoms B. This results in the formation of a concentration gradient which is directed against the flow of atoms of the given type. The magnitude of this gradient will increase with the duration of the isothermal treatment under a given load to a certain value $(\Delta c)/\lambda$ (λ - characteristic linear dimension of the order of the grain size), which should be proportional to the load causing and maintaining this gradient. The above considerations can be formulated in the following manner: in a polycrystalline specimen subjected to a creep test there should take place intercrystalline adsorption, non-homogeneous along the grain surface, as a result of which the grain boundaries of the type α will become enriched by that component of the solution whose partial coefficient of self-diffusion is higher due to the grain boundaries of the type β having become depleted of this component. There are 10 figures,

SOV/126-7-4-12/26

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4 tables and 23 references, 16 of which are Soviet and 7 English.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet (Khar'kov State University)

SUBMITTED: July 26, 1957 (initially)
January 6, 1958 (after revision)

Card 12/12

SOV/126-7-5-17/25

AUTHOR: Geguzin, Ya. Ye.

TITLE: Investigation of Creep of Metals and Alloys. 7. (Issledovaniye kripa metallov i splavov. 7.) Failure During Diffusion Creep (K voprosu o razrushenii pri diffuzionnom kripe)

PERIODICAL: Fizika metallov i metallovedeniye, Vol 7, Nr 5, pp 742-746 (USSR)

ABSTRACT: This article reports observations made in the metallographic study of copper specimens which had either fractured in creep tests or were at a stage preceding fracture. In order to study changes occurring in the vicinity of grain boundaries copper wire specimens, a considerable length of which consisted of single crystals (bamboo structure), were used. In specimens of such a structure mutual blocking of neighbouring grains during deformation is practically impossible, and therefore changes occurring in the grain boundary can be observed in their pure form. In order to obtain specimens with a bamboo structure a copper wire (99.95%) of 0.5 mm diameter was alternately deformed in tension by 2-3% and annealed at a temperature of 1000°C. The

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Investigation of Creep of Metals and Alloys. 7. Failure During Diffusion Creep

required structure was obtained after 4 to 5 cycles of such treatment. Creep tests were carried out in a quartz apparatus at 1000°C with the application of a specific load of P = 10 kg/cm^2. The experiments were carried out in a vacuum of approximately 10^{-3} mm Hg. Two identical specimens were simultaneously tested under identical conditions. When one of the specimens had fractured, the testing of the second one, which was in a state preceding fracture, was discontinued. The external appearance and microstructure of the specimen was studied with a metallurgical microscope. Sections etched with ammonium persulphate, and unetched sections, were studied. In an inspection of wires which had undergone creep testing the following points were observed:

(a) The original smooth wire which had a cylindrical shape had assumed a steplike shape after testing as a result of neighbouring grains slipping with respect to one another along their grain boundaries;

(b) The grain boundaries exhibited porosity. The slipping of neighbouring grains with respect to each other is shown

Investigation of Creep of Metals and Alloys. 7. Failure During Diffusion Creep

in Fig.1, in which the external appearance of separate portions of the specimen is shown, and in Fig.2, in which the cross-sections of specimens are shown; in certain areas of the microstructure separate fine pores, or chains of pores, can be seen (see Fig.3). This porosity may be the result of coagulation of vacancies. In Fig.4 the microstructure of the alloy after annealing at 1000°C for 4 hours is shown. In order that vacancies should coagulate the presence of oxide particles in the grain boundaries is essential. The formation of coagulated vacancies in a stressed specimen as a result of large macroscopic pores can be confirmed as has been theoretically discussed by Pines (Ref.2) and Machlin (Ref.3) where it was pointed out that these phenomena lead to a shortening of the specimen's life. Mirkin (Ref.7) has shown that zones directly adjoining the fracture area of the specimen exhibit lower microhardness. The authors explain this by an enrichment of the indicated zone by vacancies. The appearance of porosity in the grain boundaries as well as the slip of grains relative to each other lead to an increase in the specific load, and this accelerates the failure of the specimen.

SOV/126-7-5-17/25

Investigation of Creep of Metals and Alloys. 7. Failure During Diffusion Creep

Card 4/4 There are 4 figures and 9 references, of which 5 are Soviet, and 4 English

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet im. A. M. Gor'kogo (Khar'kov State University imeni A. M. Gor'kiy)

SUBMITTED: July 26, 1957

66890

SOV/126-8-1-7/25

18.6100

AUTHORS: Geguzin, Ya. Ye. and Ovcharenko, N.N.

TITLE: Relief of Metallic Powders

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 8, Nr 1, pp 38-44 (USSR)

ABSTRACT: The experiments described were undertaken to study the surface condition of sintered metal powder objects, especially the details of pore form to supplement Geguzin's earlier work (Ref 6) on spheroidization. Conditions in the bulk of a copper-powder object during sintering were simulated by polishing one surface and wrapping in copper foil (to expose it to a copper vapour at the constant experimental temperature). Annealing was carried out at 10^{-3} mm Hg, mean particle size (of electrolytic copper) was about 50 μ and initial porosity was 35-40%. After the annealing the polished surface was studied under type MIM-6 and MIM-3 microscopes. It was found that the polished surface becomes covered with "macroscopic" irregularities about 100 μ apart (Figs 1 and 2). Each of these irregularities contains the step-like "natural" roughness (step size about 0.5 μ)

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Relief of Metallic Powders

previously described by the authors (Refs 1,3) which, after prolonged annealing generally (Fig 3) but not always (Fig 5) have equiponderant shapes. At some points of the surface a pore is bounded by several particles (Fig 6). Because pore spheroidization is combined with formation of natural roughness, the equilibrium pore shape is octahedral. To check their previous conclusions (Ref 3) on the role of evaporation and condensation in the production of natural roughness further experiments were undertaken. In these identical specimens obtained by compressing copper powders were annealed in their own vapour at 750, 800, 870 and 930°C, with periodic interruption to permit examination of the surface. The time required to produce a given degree of natural roughness at the different temperatures was found. The natural logarithm of this time was found to increase linearly with increasing value of the inverse of the annealing temperature (Fig 8). The value of the heat of evaporation found from this was 80 x 10^3 cal/mol. This is close to the heat of vaporization of copper and confirms the importance of vaporization phenomena in

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Relief of Metallic Powders

"natural roughness" formation.
There are 8 figures and 10 references, 6 of which are Soviet, 3 German and 1 English.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet imeni A. M. Gor'kogo (Khar'kov State University imeni A.M.Gor'kiy)

SUBMITTED: April 5, 1958

Card 3/3

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SOV/126-8-5-12/29

AUTHORS: Geguzin, Ya.Ye., and Ovcharenko, N.N.

TITLE: Investigation of the Reasons for the Diffusion "Activity" of Crystalline Solids Containing Distortions. II - On Sintering of Metals of Galvanic Origin According to Experimental Results with Models

PERIODICAL: Fizika metallov i metallovedeniye, Vol 8, 1959, Nr 5, pp 714-720 (USSR)

ABSTRACT: In this article results of experiments are given in which a porous solid was modelled by a set of short wires of galvanic origin, i.e. wires made by the same process by which "active" powders are made. Experiments with such models represent the next step on the way from the study of wire models with an undistorted lattice to the study of the actual powder objects. It can be assumed that experiments with such models may produce additional information on the reasons for the increased speed and special kinetics of volume contraction of powder pressings. Copper wires of galvanic origin were obtained in a continuous plating bath, the layout of which is shown in Fig 1. An annealed wire of 50-70 μ diameter was placed coaxially with a cylindrical copper

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Investigation of the Reasons for the Diffusion "Activity" of Crystalline Solids containing Distortions. II - On Sintering of Metals of Galvanic Origin According to Experimental Results with Models

electrode, and the wire could be moved at a given rate along the electrode axis. A layer of galvanic copper was deposited on the wire, and the thickness of the deposit was controlled by varying the current density or the speed at which the wire was moved. A U-tube, filled with water, was attached to the end of the bath for washing the filament. A wire of uniform thickness could be obtained only when the copper was deposited on a moving wire. Experiments with deposition on a stationary wire have shown that the latter, due to a fall in potential along its length, becomes conical. The authors used an acid solution under the following conditions: $I = 5 A/dm^2$, rate of motion $v = 3 \times 10^{-2}$ cm/sec. The wire thus obtained was sized by drawing through a diamond tie, the diameter of which was approximately 5 μ less than that of the wire. As the result, small irregularities on the wire surface were ironed out. The specimens were prepared by a method used before by Geach et al and

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Alexander et al (Refs 7 and 8). The wire was wound in several layers on a copper reel of 8 mm diameter. Winding was carried out on a special device in which contact between the coils could be controlled by means of a microscope (a load of approximately 100 g suspended from the wire during coiling ensured regular close contact between the coils). This method was used for the preparation of specimens of "galvanic" and ordinary wires. The main experiments were carried out on wires of 120 μ diameter. Diffusion annealing was carried out in vacuum at 750, 870 and 1020 °C. The annealed reels were pressed into AST-1 plastic material, which polymerizes at 30 °C. Metallographic sections were prepared from diameter sections of the reel. The structure was inspected after repeated polishing and etching with a solution of ammonium persulphate in ammonia. Results obtained in three series of isothermal annealing are shown in Figs 2a-B and 3a-2. Fig 4 shows the cross-

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section of the wire after annealing at 750 °C for 20 hours (X 500). Figs 5, 6 and 7 show the cross-sections of wire coils after annealing at 1020 °C for various lengths of time (Fig 5 - ordinary wires, Figs 6 and 7 - wires of "combined" specimens). The authors have gained information about the temperature dependence of the effective self-diffusion coefficient relationship between ordinary copper D_o and galvanic copper D_i ($\chi = D_i/D_o$). By using the experimental value of χ, at three different temperatures, and knowing the activation energy of the process of self-diffusion of copper in an equilibrium lattice (Q_o) (Ref 8), the value of $\lambda = Q_o/Q_i$ can be estimated, where Q_i is the activation energy of the sintering process of galvanic wires. A table on page 718 shows values of χ and λ for different temperatures. The relationship between chords which form at the boundary between two wires of galvanic origin Y_{ii}, one wire of galvanic and one of ordinary origin Y_{io}

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Investigation of the Reasons for the Diffusion "Activity" of Crystalline Solids containing Distortions. II - On Sintering of Metals of Galvanic Origin According to Experimental Results with Models

and two ordinary wires Y_{oo} has been worked out mathematically. The authors conclude that wires of galvanic origin become fused to each other considerably faster than ordinary wires. The approach of galvanic wires to equilibrium is accompanied by a coarsening of the diffusion pores which are situated mainly along the grain boundaries. Fusion of wires of the same metals to each other possessing 'different' diffusion activities is considered. Experiments on combined specimens consisting of galvanic and ordinary wires showed that the experimentally observed chords agree in magnitude with those predicted on the basis of the diffusion mechanism of high-temperature sintering.

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There are 7 figures, 1 table and 10 references, of which 6 are Soviet, 3 English and 1 International.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet imeni A.M. Gor'kogo; Nauchno-issledovatel'skiy institut khimii KhGU

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SOV/126-8-5-12/29

Investigation of the Reasons for the Diffusion "Activity" of Crystalline Solids containing Distortions. II - On Sintering of Metals of Galvanic Origin According to Experimental Results with Models

(Khar'kov State University imeni A.M. Gor'kii; Scientific Chemical Research Institute of Khar'kov State University)

SUBMITTED: February 16, 1959

Card 6/6

24 (4)
AUTHORS: Aronova, P. N., Geguzin, Ya. Ye. Ocharenko, N. N.

SOV/32-25-5-37/56

TITLE: On X-ray Photography at Low Temperatures (O rentgenografirovanii pri nizkikh temperaturakh)

PERIODICAL: Zavodskaya Laboratoriya, 1959, Vol 25, Nr 5, p 618 (USSR)

ABSTRACT: In the present investigation the standard X-ray camera RKD (Fig) was used for taking radiograms at temperatures of liquid nitrogen or oxygen. The adjusting arrangement and the microscope stage were exchanged for a plexiglass cylinder (fastened with the adhesive BF-2). A Dewar vessel is then put into the cylinder, and the liquid nitrogen is filled into the vessel. In contrast with another type of construction (Ref 1) the sample is in the present case in direct contact with liquid nitrogen; this method permits also the investigation of materials of very low heat conductivity. The camera modified in such a way is successfully used for the purpose of investigating crystal lattice deformations in rock salt and metal powders.

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On X-ray Photography at Low Temperatures SOV/32-25-5-37/56

There are 1 figure and 1 Soviet reference.

ASSOCIATION: Khar'kovskiy gosudarstvennyy pedagogicheskiy institut i Khar'kovskiy gosudarstvennyy universitet (Khar'kov State Pedagogical Institute and Khar'kov State University)

Card 2/2

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18(0) SOV/20-124-5-23/62

AUTHOR: Geguzin, Ya. Ye.

TITLE: On the Diffusion Activity of a Metal of Galvanic Origin (O diffuzionnoy aktivnosti metalla gal'vanicheskogo proiskhozhdeniya)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 124, Nr 5, pp 1045-1048 (USSR)

ABSTRACT: The following paper describes some experimental results obtained and deals with the possible causes of the increased diffusion activity of galvanically produced metals. Investigation of this problem may contribute towards explaining the details of sintering in connection with the pressing of "active" powders. The shrinking of porous pressed specimens of "active" powders under isothermal conditions takes place at a decreasing rate. According to present opinions, this is a consequence of the reduction of the self-diffusion coefficient with a decrease of distortions, and thus a consequence of the decrease of the diffusion activity of powder granules in the case of isothermal annealing. In order to obtain data concerning the cause of increased diffusion activity and its reduction, the author carried out sintering tests on models

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consisting of galvanically produced wires. These wires were produced by the depositing of copper from an acid bath onto a thin copper base (50-70 μ). The author carried out simultaneous investigations of three different types of samples made from a) a galvanically produced wire, b) from ordinary wire, and c) combined samples, i.e. with alternating layers of galvanic and ordinary wire. The samples were annealed at temperatures 750, 870, and 1,020°. Two figures show typical structures. In the course of the investigation of microstructures the following qualitative observations were made: 1) The galvanically produced samples are sintered more rapidly than the ordinary ones. 2) The average linear dimensions of pores formed during the annealing of galvanically produced wires increase with progressing time. The visible pores are in this case distributed among the elements of macrostructure. 3) The metal of the coating recrystallizes more slowly then the metal of the base, and therefore the structural individuality of the coating and of the base is conserved up to more advanced stages of the sintering process. The diffusion activity in the range of various temperatures

may be due to various causes. At temperatures at which microdistortions vanish, surplus vacancies accumulate in the lattice, and the existence of these vacancies increases the self-diffusion coefficient. These vacancies err about in the lattice, accumulate in the various impurities, and form a very highly developed network of surface and macroscopic pores. At high temperatures, at which the microdistortions of the lattice have practically already vanished, the increased value of the self-diffusion coefficient may be due to the following causes: As a result of the existence of a developed network of free surfaces in the metal, surface diffusion makes a noticeable contribution to the experimentally observable diffusion current. It is by this that the increased degree of efficiency of self-diffusion near melting point may be explained. In the case of diffusion of surplus vacancies on the boundaries of the elements of micro- and macrostructures there is yet another cause for increased diffusion activity, viz. the existence of a very highly developed network of free surfaces. Diffusion along this surface makes a noticeable

contribution to the experimentally observable diffusion current. The author thanks N. N. Ovcharenko for his assistance in metallographical work. There are 1 table and 17 references, 14 of which are Soviet.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet im. A. M. Gor'kogo (Khar'kov State University imeni A. M. Gor'kiy)

PRESENTED: October 6, 1958, by G. V. Kurdyumov, Academician

SUBMITTED: October 4, 1958

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E193/E383

AUTHORS: Geguzin, Ya.Ye. and Ovcharenko, N.N. (Khar'kov)

TITLE: On the "Intrinsic Roughness" of a Polycrystal

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1960, Nr 3, pp 48 - 52 (USSR)

ABSTRACT: It is a generally known fact that a polished surface of a polycrystal specimen, annealed at elevated temperatures, ceases to be flat owing to the appearance of a network of grooves and/or steps, standing out in relief. This phenomenon has been studied previously by the present authors (Refs 2-6), who have arrived at the conclusion that this effect is associated with the anisotropy of the coefficient of surface tension and who, consequently, have coined a term "intrinsic roughness" to describe roughness due to high-temperature annealing. L.B. Erlikh, who had also studied this effect, has recently published a paper (Ref 17) in which he postulates that roughening of a polished surface of a polycrystal during high-temperature annealing is a result of the deformation of a thin surface layer, which is caused by compressive stresses, set up in the surface layer owing to its temperature being higher

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On the "Intrinsic Roughness" of a Polycrystal

than that of the interior of the specimen. The present authors reject these hypotheses and describe the results of several recent experiments which give additional support to their own theory. Thus, when a piece of copper foil, folded to form a hollow sphere, was vacuum-annealed, it was the inside surface that became rough (Figure 1), whereas according to Erlikh's theory, this effect should be confined to the outside surface. Again, when a single crystal of NaCl was annealed at 750 °C in an atmosphere of its own vapours, the (100) plane remained smooth, whereas roughening of the artificially produced (150) plane took place (Figures 2b and a, respectively), a similar effect having been observed on single germanium crystals (Ref 14). Examination of recrystallized copper specimens, heated under conditions promoting the onset of "intrinsic roughness", showed that side by side with roughened grains (Figure 3b) or twins (Figure 3a) there were grains or twins whose surface remained flat; these results cannot be attributed to the deformation of the surface layer due to the presence of a temperature gradient. Lastly, polished

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On the "Intrinsic Roughness" of a Polycrystal

specimens of polycrystalline copper were heated at a constant rate of heating to various temperatures; the polished surface became rough at temperatures higher than 800 °C, whereas at lower temperatures, slight roughening of the surface occurred only after prolonged treatment. These observations disprove Erlikh's hypothesis on the part played by the temperature gradient in the phenomenon under consideration, since under the conditions of heating by radiation, the temperature gradient decreases with rising temperature of the specimen, reaching zero when the specimen reaches the furnace temperature. The experimental results described above, combined with theoretical considerations leave, in the opinion of the present authors, no doubt that anisotropy of the surface tension coefficients plays a predominant part in the onset of "intrinsic roughness". There are 3 figures and 19 references, 15 of which are Soviet and 4 English.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet Nauchno-issledovatel'skiy institut khimi pri KhGU (Khar'kov State University - Chemical Research Institut)

SUBMITTED: December 3, 1959

Card3/3

GEGUZIN, Ya.Ye.; OVCHARENKO, N.N.

Properties and stability of distortions in the crystal lattices of an electrolytically prepared metal. Izv.vys.ucheb. zav.; chern.met. no.3:165-168 '60. (MIRA 13:4)

1. Khar'kovskiy gosudarstvennyy universitet.
(Crystal lattices) (Metallography)

GEGUZIN, Ya.Ye.; STARTSEV, V.I.; BURAVLEVA, M.G.; MADIKYAN, R.A.; MARBUT, T.P.; SHPUNT, A.A.

Cloudiness ("agine") of pellets pressed from ionic crystal powders. Kristallografiia 5 no.2:295-302 Mr-Ap '60. (MIRA 13:9)

1. Kharkovskiy f lial Vsesoyuznogo nauchno-issledovatel'skogo instituta khimicheskikh reaktivov.
(Salt) (Potassium chloride)

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AUTHORS: Geguzin, Ya.Ye. and Kulik, I.O.

TITLE: Investigation of Certain Physical Phenomena Occurring at High Temperature on the Surface of Crystalline Substances. IV. Analytical Study of the Kinetics of "Self-Healing" of Artificial Defects on the Surface of Solid Bodies

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol 9, Nr 3, pp 379-384 (USSR)

ABSTRACT: When single crystals or polycrystalline substances are maintained at elevated temperatures, physical changes occur which lead to a decrease in the free surface energy. The object of the investigation, described in the present paper was to derive expressions describing the kinetics of the process of "self-healing" (levelling) of artificial surface defects, in the belief that analytical solution of this problem would assist in the experimental studies of the abovementioned phenomena. The calculations were carried out for a defect whose geometry is illustrated in Fig 1, this shape having been chosen owing to its simplicity and also because it can be easily reproduced

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Investigation of Certain Physical Phenomena Occurring at High Temperature on the Surface of Crystalline Substances. IV. Analytical Study of the Kinetics of "Self-Healing" of Artificial Defects on the Surface of Solid Bodies

experimentally. In the case of crystalline bodies, three mechanisms of the process of "self-healing" can be distinguished: volume diffusion, surface diffusion and transfer of the material by the vapour phase (re-condensation). Although these three mechanisms operate simultaneously, each of them was analyzed separately by the present authors in order to establish the conditions under which a given mechanism plays the predominant part. The relative contribution of the volume and surface diffusion can be assessed from the first principles of the theory of diffusion (Ref 3 and 6). For a given magnitude of the gradient, determining the diffusion flux, the ratio between the volume and surface diffusion fluxes ($J_v:J_s$) is, in the case under consideration, given (Ref 3,5) by $\varepsilon \simeq D_v L/D_s \Delta$, where: L - width of the scratch; Δ - thickness of the layer in which surface diffusion takes place; its

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Investigation of Certain Physical Phenomena Occurring at High Temperature on the Surface of Crystalline Substances. IV. Analytical Study of the Kinetics of "Self-Healing" of Artificial Defects on the Surface of Solid Bodies

magnitude is of the order of the lattice parameter at temperatures near the melting point. If $L \simeq 10^{-4}$ cm, $\Delta \simeq 10^{-7}$ cm, $D_v/D_s \simeq 10^{-6}$ cm^2/sec, then $\varepsilon \simeq 10^{-3}$, ie the volume diffusion flux is small in comparison with the surface diffusion. Although, in the case of large scratches ($L \simeq 10^{-1}$ to 10^{-5} cm), this conclusion may not be correct, the problem under consideration was analyzed under the assumption that only surface diffusion and re-condensation play a significant part in the process of levelling of a surface scratch. The factor which, in the case of both mechanisms, stimulates "self-healing" is the existence of a chemical potential gradient along the line joining the flat surface of the crystal with the centre (root) of the crack (Ref 3,5). The kinetics of the process of "self-healing" of such a crack are described by differential equations derived by Mullins (Ref 3) for the process of formation of a symmetrical groove between

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two adjacent grains in a polycrystalline specimen, Eq (1) relates to the re-condensation mechanism, Eq (2) to the mechanism of surface diffusion, the constants A and B being given by Eq (3) and (4) respectively, where: P - equilibrium vapour pressure; V - volume occupied by one atom in the crystal lattice; m - atomic mass; n - surface atom density; D_s - surface diffusion coefficient; k - Boltzman constant; T - absolute temperature; σ - surface tension coefficient assumed to be isotropic; δ - interatomic distance (lattice parameter). The solution of Eq (1) for the case of scratch illustrated in Fig 1, obtained for the starting and limiting conditions given by Eq (5), takes the form given by Eq (6). Since, under experimental conditions, it is easiest to determine the variation of the depth h of the scratch, an expression for h at a given moment was obtained from Eq (6); this expression

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is reproduced as Eq (7), where $\tau = 4At/\ell^2$ represents dimensionless time. The relationship between $h(t)/h_o$ and τ is represented by curve b in Fig 2. When T is large, the relationship described by Eq (7) becomes asymptotic and is given by Eq (7a). Since at $\tau = 1$, $h/h_o = 1/2$, the half-time of the "self-healing" process can be obtained from the formula given as Eq (8). It is pointed out in this connection that if the half-time $t^2_{1/2}$ is determined experimentally and if the vapour pressure of the investigated substance is known, it is possible to calculate the surface tension coefficient from the formula given as Eq (9). With the aid of Eq (6), it is possible to construct curves, representing the shape of the scratch at various τ. Curves of this type, constructed for the re-condensation mechanism, are

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Investigation of Certain Physical Phenomena Occurring at High Temperature on the Surface of Crystalline Substances. IV. Analytical Study of the Kinetics of "Self-Healing" of Artificial Defects on the Surface of Solid Bodies

reproduced in Fig 3. The solution of Eq (2) describing the kinetics of "self-healing" of the crack, illustrated in Fig 1, by the mechanism of surface diffusion was obtained for the starting and limiting conditions, given in Eq (10). The general solution is given by Eq (11) from which a formula (Eq (12)), describing the variation of the depth h of the scratch with time, was derived; in this formula $\zeta = 16Bt/l^4$ represents dimensionless time. For $\zeta > 1$, $\varphi(\zeta)$ can be determined with the aid of an asymptotic function, given as Eq (12a), from which it will be seen that the depth of the scratch varies with time, according to $h \sim t^{-1/4}$. Curve a in Fig 2 represents the relationship $h/h_0 = \varphi(\zeta)$. Since at $\zeta = 1$ $h/h_0 = 1/2$, the half-time of the "self-healing" process (taking place by the mechanism of surface diffusion) can be calculated from Eq (13). From Eq (4) and (13) a formula for the surface diffusion coefficient can be

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Investigation of Certain Physical Phenomena Occurring at High Temperature on the Surface of Crystalline Substances. IV. Analytical Study of the Kinetics of "Self-Healing" of Artificial Defects on the Surface of Solid Bodies

derived in the form given by Eq (14). Thus, experimental data on "self-healing" of surface defects by the mechanism of surface diffusion can be used for determining the coefficient of surface self-diffusion. Graphs, showing the varying of the profile of the scratch in time, are reproduced in Fig 4. Regarding the relative parts played by these two mechanisms in the investigated process, they can be assessed by considering the ratio γ of the half-times of the "self-healing" processes, which is given by Eq (15). It will be seen that γ depends, to a large extent, on the width of the scratch l, which means that the re-condensation mechanism, insignificant in the initial stages of the "self-healing" process, may play the predominant part in its final stages. This is due to the fact that as the width of the scratch increases, so does the diffusion path, whereas the rate of transfer of the material by the

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Investigation of Certain Physical Phenomena Occurring at High Temperature on the Surface of Crystalline Substances. IV. Analytical Study of the Kinetics of "Self-Healing" of Artificial Defects on the Surface of Solid Bodies

vapour phase is independent of the distance. Unfortunately, in the absence of data on D_s, no qualitative assessment of the magnitude of γ can be made. However, there is no doubt that as the temperature of the substance approaches its melting point, the part played by the re-condensation process becomes larger since both P_o and D_s increase exponentially with rising temperature and the heat of evaporation is always larger than the activation energy of surface self-diffusion. The present authors calculated the approximate value of γ for several metals characterized by low vapour pressure. To simplify the calculations, it was assumed that the surface diffusion coefficients are isotropic and that the crystal lattice in the vicinity of the scratch is in the state of equilibrium, ie free from micro-defects. Taking $D_s \simeq 10^{-4}$ to 10^{-5} cm^2/sec, $n \approx 10^{15}$ cm^{-2}, 4

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and $1 \approx 10^{-4}$ cm, the following values of γ were obtained for copper, silver, gold and nickel: $\gamma Cu \simeq 10^{-4}$; $\gamma Ag \approx 10^{-3}$; $\gamma Au \approx 10^{-6}$, $\gamma Ni \simeq 10^{-3}$. There are 4 figures and 8 references, 6 of which are Soviet and 2 English.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet
Khar'kovskiy filial IRYeA (Khar'kov State University
Khar'kov Branch of IRYeA)

SUBMITTED: July 3, 1959

Card 9/9

GEGUZIN, Ya.Ye.; OVCHARENKO, N.N.

Investigating certain physical processes occurring on the surface of crystalline solids at high temperatures. Part 5. Self-correction of defects purposely produced on the surface of polycrystalline copper. Fiz. met. i metalloved. 9 no. 4:569-577 Ap '60. (MIRA 14:5)

1. Khar'kovskiy gosudarstvennyy universitet im. A.M. Gor'kogo.
(Surface tension) (Diffusion) (Metals at high temperatures)

80883

S/126/60/009/006/007/025
E111/E352

AUTHOR: Geguzin, Ya.Ye.

TITLE: Investigation of Reasons for Diffusion "Activity" of Crystalline Bodies with Distortions V. Reasons for the Diffusion "Activity" of Metals With Macroscopic Structural Heterogeneities

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol 9, Nr 6, pp 842 - 851 (USSR)

ABSTRACT: Diffusion processes in metals with macroheterogeneities are known to be abnormally rapid, especially in electrodeposited porous metals (Refs 1-3). In the present article the author discusses this with particular reference to the mechanism and kinetics of the compacting of porous compressio blanks. He deals first with the vacancy mechanism. None of three possible conditions for this mechanism satisfies the experimental facts. Supersaturation of the crystal lattice with vacancies cannot persist for long; the excess vacancies dispersing by meeting structural heterogeneities or by replacement by atoms located between points. The author shows that the corresponding characteristic times are negligibly small and that neither the existence of ex

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S/126/60/009/06/007/025
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Investigation of Reasons for Diffusion "Activity" of Crystalline Bodies with Distortions V. Reasons for the Diffusion "Activity" of Metals with Macroscopic Structural Heterogeneities

atomic vacancies nor reduction in the barriers for their movement can explain the observed facts. He goes on to consider the role of the network of boundaries and cracks between the macro- and microstructural elements and micro-cracks. Although systematic data on diffusion coefficients along boundaries are not available, there are sufficient to compare the solid, boundary and surface diffusion coefficient for some metals (table). Some direct evidence on the important role of boundaries, etc. is available (e.g. Refs 15-20, 22, 23, 40). Similar evidence is provided also by work on the influence of pressure on poly-crystalline bodies (Refs 25-28). On the basis of these views and a simplified model in which undisturbed lattice alternates with flat gaps (comb-like structure) the author provides semiquantitative estimations of the contribution of boundary and surface diffusion to the observed diffusion flow. He estimates the rate of "healing" by diffusion of an isolated pore and examines the role of boundaries and

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Investigation of Reasons for Diffusion "Activity" of Crystalline Bodies with Distortions V. Resons for the Diffusion "Activity" of Metals with Macroscopic Structural Heterogeneities

cracks in the sintering of a cylindrical pore and shows that Kuszinsky's (Ref 24) views on this are incorrect. He emphasises that the ideas presented in the present article provide no support for the view (Ref 21) that the volume shrinkage of powders during sintering is due mainly to the diffusional movement of material along particle surfaces. There are 1 table and 40 references, 25 of which are Soviet, 7 English, 2 German and 6 international.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet im. A.M. Gor'kogo (Khar'kov State University imeni A.M. Gor'kiy)

SUBMITTED: January 25, 1960

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GEGUZIN, YA.YE.

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81903

S/126/60/010/01/005/019
E111/E335

187500

AUTHORS: Geguzin, Ya.Ye., Kovalev, G.N. and Ratner, A.M.

TITLE: Investigation of Certain Physical Processes Taking Place on the Surface of Crystalline Bodies at High Temperature. VI. Method of Determining Coefficients of Surface Self- and Hetero-diffusion in Crystalline Bodies

PERIODICAL: Fizika metallov it metallovedeniye, 1960, Vol.10, No.1, pp 47 - 57

TEXT: The authors point out that comparatively little information is available on diffusion on surfaces. They describe their work to develop a method for determining the surface-diffusion coefficient and the thickness of the layer in which such diffusion occurs. The latter has been found to be thicker (Ref.3) than indicated by calculations where Fisher's model (Ref.1) was used. In their method many plates (about 100 microns thick) are made into a pack, along one polished surface of which (perpendicular to the plates) a radioactive isotope of the diffusing element is deposited (Fig.1a). There is little direct contact between

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plates. Diffusion occurs both within a plate and along its gap-adjacent surfaces, and also from the latter into the plate: a characteristic distribution is obtained (Fig.1b). From this, with equations developed by the authors, the self- and hetero-diffusion coefficients can be calculated, using a simplified representation (Fig.2); graphical methods can be used (Figs.3 and 4) for calculation. The authors go on to discuss the possible role of gaseous diffusion, showing that with their size of interplate gap this cannot be significant: the critical gap width is given by the square root of the product of the surface-diffusion coefficient and the life of an atom on the wall surface. This conclusion was verified by a special series of experiments in which iron strips were arranged between two plates, one covered with a layer of Fe^{59}. Two sizes of gap were arranged between strips (Fig.5). Radioactivity of the plates was determined,

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excluding surface diffusion, after annealing at 680 °C. The authors report preliminary determinations of surface self-diffusion in alpha iron. Armco-iron strips 9×10^{-3} cm thick, 3×10^{-1} cm wide, were studied by the pack technique, diffusion annealing being effected in oxygen-free argon at 550, 600, 640, 650 and 680 °C. Fig.6 shows an autoradiograph of a specimen and Fig.7a the distribution of radioactivity with distance from specimen edge. Fig. 7b gives plots of functions derived from Fig.7a. Data relating to surface diffusion in alpha-iron are tabulated and the logarithm of the surface-diffusion coefficient is shown (Fig.8) to be linearly related to the reciprocal of absolute temperature. The surface-adjacent layer in which surface diffusion takes place was found to be several hundred atom layers thick: no explanation is available of the existence

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Investigation of Certain Physical Processes Taking Place on the Surface of Crystalline Bodies at High Temperature. VI. Method of Determining Coefficients of Surface Self- and Hetero-diffusion in Crystalline Bodies

and temperature stability of such a layer.
There are 8 figures, 1 table and 16 references: 11 Soviet and 5 English.

ASSOCIATIONS: Khar'kovskiy gosudarstvennyy universitet im. A.M. Gor'kogo (Khar'kov State University im. A.M. Gor'kiy),
Ukrainskiy institut metallov (Ukrainian Institute of Metals,
Khar'kovskiy filial IREA (Khar'kov Branch of IREA)

SUBMITTED: January 25, 1960

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S/020/60/130/03/015/065
B014/B014

AUTHORS: Geguzin, Ya. Ye., Ovcharenko, N. N.

TITLE: Self-healing of Defects on the Surface of Crystalline Bodies at High Temperatures

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol 130, Nr 3, pp 537 - 540 (USSR)

ABSTRACT: The authors first discuss experiments made by P.I. Lukirskiy (Ref 1) which showed that spontaneous processes occurring on the surface of crystalline bodies at high temperatures lead to a decrease in surface energy. The present paper is intended to study the decrease in surface energy in the leveling of a surface with macroscopic defects. The defects are healed by volume diffusion, surface diffusion, or substance transport by the gaseous phase. It is noted that volume diffusion is negligible in this case. According to equation (1), the self-diffusion coefficient of the surface is determined from the leveling rate. The surface tension of the solid phase is calculated from equation (2). The anisotropy of surface tension is not taken into account by the above-mentioned formulas. The

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Self-healing of Defects on the Surface of Crystalline Bodies at High Temperatures

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"half-lives of healing" were compared to one another according to (3) in order to determine the relative part played by the two mechanisms in healing. For crystals with high vapor pressure, especially for ion crystals, the substance transport by the gaseous phase is described to be predominant in healing. This was confirmed by experiments on the healing of scratches of rock-salt crystals. Text, the authors describe experiments on high-temperature leveling which were made with copper free of oxygen. Annealing was carried out in a vacuum, protective argon- or hydrogen atmosphere at 600°C, 700°C, 850°C, and 950°C. An interferometer was used for observations. The diffusion coefficients determined from the leveling kinetics are consistent with those mentioned in publications. In view of the fact that a smooth profile of the scratch developed in healing, the authors assumed that the surface was covered with a thin amorphous layer. They arrived at this conclusion because of similar results obtained for glass. This is, however, inconsistent with electron diffraction studies carried out in experiments with metals. In this connection the so-called Bayley layer is mentioned. It is assumed that this behavior results from a thin,

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Self-healing of Defects on the Surface of Crystalline Bodies at High Temperatures

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hyperfine surface layer whose elements are strongly deoriented. Accordingly, the coefficient of surface tension seems to be anisotropic. The resistivity of the thin layer to recrystallization apparently consists in a partial disconnection of the structural elements, which is caused either by condensates on the surface of the structural elements or by oxide layers. There are 2 figures and 12 references, 8 of which are Soviet.

ASSOCIATION: Institut khimii pri Khar'kovskom gosudarstvennom universitete im. A.M. Gor'kogo (Institute of Chemistry at Khar'kov State University imeni A.M. Gor'kiy)

PRESENTED: October 8, 1959, by P.A. Rebinder, Academician

SUBMITTED: September 28, 1959

S/020/60/135/004/017/037
B019/B077

AUTHOR: Geguzin, Ya. Ye.

TITLE: The Influence of Pressure on the Coalescence Process and the Healing of Microporosity in Crystals

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol. 135, No. 4, pp. 829-832

TEXT: The influence of a universal pressure on the coalescence and healing of micropores caused by plastic deformation was investigated. In the first part, some estimates of this influence are given on the basis of the following equations:

$$\Delta\xi_r^P = \xi_r - \xi^P \quad ; \quad \xi_r = \xi_0\left(1+\frac{2\sigma\Omega}{rkT}\right) ;$$

$$\xi^P = \xi_0 \exp(-P\Omega/kT)$$

ξ_r^P denotes the vacancy excess of the defective surface with a radius r if a pressure P is applied to the crystal; ξ_r and ξ^P are the vacancy concentrations near the defective surface or far away from it; ξ_0 is the vacancy concentration in the crystal without pressure; σ is the surface tension;

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and Ω is the volume of a vacancy. The change of vacancy concentration under pressure is considered to be caused by the change of the pore radius. An effective radius $\tilde{r} = r/(1+\alpha P)$ is formed, with $\alpha = r/2\sigma$. There is a critical pore radius above which the pores start to grow by decreasing excess vacancies or other pores. The critical pore radius is given by $r^* = (\xi_0/\Delta\xi)2\sigma\Omega/kT$. The relation between the critical radii under pressure and without pressure is given by $\tilde{r}^* = r_0^*/(1-\beta P)$ with $\beta = r_0/2\sigma$. From these estimates it follows that the healing of micropores is very pressure-dependent. Experiments with single crystals of sodium chloride and polycrystalline copper showed that the estimates and conclusions were correct. Single crystals of sodium chloride subjected to plastic deformation lost their transparency. Annealing under normal atmospheric pressure at 500°C brought back their transparency after 30 minutes. Annealing at 575° and 650°C under pressures of up to 50 atm accelerated this process considerably. The Cu specimen was annealed at 1000°C and pressurized up to 50 atm. Here again a coalescence of the pores and a collecting recrystallization was observed in the metallographic specimens. These results are explained by the fact

that the portion of the diffusion coefficient which is determined by the diffusion of the surface is larger in bodies with microcracks. Estimates showed that this portion outweighs the portion of volume diffusion by a factor of three. I. M. Lifshits, V. V. Slezov, and L. M. Polyakov are mentioned. N. N. Ovcharenko and L. N. Paritskaya are thanked for their help in the experiments. There are 4 figures and 8 references.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet im. A. M. Gor'kogo (Khar'kov State University imeni A. M. Gor'kiy)

PRESENTED: June 27, 1960, by P. A. Rebinder, Academician

SUBMITTED: June 20, 1960

FEDORCHENKO, Ivan Mikhaylovich; ANDRIYEVSKIY, Rostislav Aleksandrovich; BAL'SHIN, M.Yu., kand. tekhn.nauk, retsenzent; BOROK, B.A., kand. tekhn.nauk, retsenzent; GEGUZIN, Ya.Ye., prof., doktor fiz.-mat.nauk, retsenzent; SAMSONOV, G.V., prof., doktor tekhn.nauk, retsenzent; POKROVSKAYA, Z.S., red.; KADASHEVICH, O.A., tekhn. red.

[Principles of powder metallurgy] Osnovy poroshkovoi metallurgii. Kiev, Izd-vo Akad.nauk USSR, 1961. 420 p. (MIRA 14:12)
(Powder metallurgy)

20129
S/181/61/003/002/027/050
B102/B212

24 7500 1035, 1158 1160

AUTHORS: Geguzin, Ya. Ye. and Polyakov, L. M.

TITLE: Investigations in the field of crystal ceramics. II. The effect of a uniform pressure on the healing kinetics of macro-defects in ion crystals

PERIODICAL: Fizika tverdogo tela, v. 3, no. 2, 1961, 520-527

TEXT: The present paper is a continuation of Ref. 13 (Geguzin and V. I. Startsev, Kristallografiya, 5, 2, 1960) and brings results of an experimental and theoretical investigation which has been performed to study the influence of uniform pressure on the healing of defects (coalescence of pores and micro-cracks) occurring during plastic deformation of NaCl-crystals. Samples measuring 5 · 6 · 15 mm (natural rock salt) have been heated to 650°C for two days and after that cooled down slowly. Samples without any defects have been selected for the test. In order to produce micro-defects (of one magnitude smaller than the wavelength of visible light) in these samples they have been deformed with an exponentially increasing load. An increase of light scattering could be observed

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during the deformation process. The mean loads applied (σ) varied between 1250 and 1350 g/mm^2. Then, the deformed samples have been exposed to heat treatment in an autoclave (60 cm^3) under uniform pressure (argon). After this, the light scattering has been studied at room temperature using an ultramicroscope. Several test series have been performed, in order to obtain useful results (isothermal treatment at 400, 500, 600, and 700°C at 1-50 atm, during τ = 30 min). The results are shown in Fig. 1: $i = (i_o - i_b)/(i_n - i_b)$ as function of pressure at four different temperatures; where i_o is the intensity of the light scattered in the crystal, i_n is that after crystal deformation, i_b is the intensity of the background. The time dependence (τ) of the light transmittance of a crystal at p = const, T = const (500°C, 1, 30, and 70 atm) has been investigated in another test series. The results are shown in Fig. 2. The temperature dependence i(t) at a constant heating rate (10°/min) has been studied also for 1 and 30 atm. At 100°C a noticeable healing process can be observed. The results may be interpreted in terms of the diffusion theory. At given test conditions and a given value of the relative supersaturation of a crystal having the vacancies ($\Delta \bar{c}_j / \bar{c}_j$) there

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Investigations in the field...

is a critical defect dimension r^*, at which defects larger than r^* coagulate at the expense of those smaller than r^*. r^* is given by $r^* = 2\sigma\Omega/\Delta\xi kT$, where Ω is the crystal volume per atom. It can be expected that a uniform pressure promotes this coalescence, i.e., heals small pores. The excess vacancy concentration $\Delta\xi_r^p$ near the surface of a pore with a radius r (under the influence of pressure p) is given by $\Delta\xi_r^p = \xi_r - \xi^p$, where ξ_r is the vacancy concentration near the pore surface, ξ^p that far from the pore. These two concentrations are determined by $\xi_r = \xi_0 (1 + \frac{2\sigma}{r} \frac{\Omega}{kT})$, $\xi^p = \xi_0 \exp(-p\Omega/kT)$. The change of $\Delta\xi_r$, if a pressure is applied, may also be expressed by the change of the pore radius (r is substituted by $\tilde{r}$): $\frac{2\sigma}{\tilde{r}} \frac{\Omega}{kT} = 1 + \frac{2\sigma}{r} \frac{\Omega}{kT} - \exp(-p\Omega/kT)$. For $p\Omega/kT < 1$, $\tilde{r} = r/(1 + \alpha p)$, where $\alpha = r/2\sigma$; analogously, the following

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expression is valid for the critical dimensions if pressure is applied: $r^* = r_0^*/(1-\beta p)$, where $\beta = r^*/2\sigma$. It is shown that experiments can be well described with these formulas. The experiments also show that under otherwise equal conditions the same healing effects (observed via light transmittance) may be obtained by either raising the temperature or the pressure. I. M. Lifshits and V. V. Slezov are mentioned. There are 4 figures and 13 references: 12 Soviet-bloc.

ASSOCIATION: Khar'kovskiy filial IRYeA Fiziko-tekhnicheskiy institut AN SSSR Khar'kov (Khar'kov Branch of IRYeA, Institute of Physical Technology AS USSR, Khar'kov)

SUBMITTED: May 30, 1960

GEGUZIN, Ya.Ye.; OVCHARENKO, N.N.

Investigation of certain processes on the surface of single crystals. Part 3. Kristallografiia 6 no.2:239-243 Mr-Ap '61. (MIRA 14:9)

1. Khar'kovskiy gosudarstvennyy universitet im. A.M.Gor'kogo
(Surfaces, Deformations of) (Rock salt crystals)

GEGUZIN, Ya.Ye.; OVCHARENKO, N.M.

Investigating certain physical processes occurring on the surface of crystals at high temperatures. Part 7: Role of viscous flow in smoothing out roughnesses on the surface of a solid. Fiz. met. i metalloved. 11 no. 5:807-809 My '61. (MIRA 14:5)

1. Institut khimii pri Khar'kovskom gosudarstvennom universitete.
(Surfaces (Technology)) (Viscosity)

S/126/61/012/001/005/020
E193/480

AUTHORS: Geguzin, Ya.Ye., Ovcharenko, N.N., Paritskaya, L.N.

TITLE: Investigation of certain processes taking place on the surface of crystalline substances at elevated temperatures. VIII. Concerning the character of levelling up of scratches on distorted surfaces of polycrystalline copper

PERIODICAL: Fizika metallov i metallovedeniye, 1961, Vol.12, No.1, pp.42-46 + 2 plates

TEXT: The results of an earlier investigation carried out by the present authors (Ref.1: FMM, 1960, 9, No.4, 569; DAN SSSR, 1960, 130, No.3, 537), showed that the process of levelling up of a scratch on a flat surface of a polycrystalline specimen is affected by its structural state. Thus, a scratch on the surface of a specimen that had undergone prolonged preliminary annealing did not disappear upon subsequent holding at elevated temperatures but only changed its profile in accordance with the orientation of the grains relative to the polished surface. On the other hand, a scratch on the surface of a preliminarily deformed specimen levelled up at a rate which increased with increasing degree of preliminary

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deformation. The object of the present investigation was to obtain additional data which would help in formulating an explanation of these effects. To this end the change of the profile of scratches on the surface of both electrolytically deposited and cast, prolycrystalline copper was studied. The scratches were made with the aid of a diamond pyramid indenter with an angle of 136° between opposite faces. The tests were carried out in hydrogen, on specimens wrapped up in copper foil to minimize the effect of volatilization. An interferometer was used to keep track of the changes in the profile of the scratches. In the first series of experiments specimens of copper electrodeposited at a current density of 0.5 and 10 amp/dm^2, and a cast copper specimen (turned, ground and polished) were studied. Upon holding at 950°C, scratches of all these three specimens levelled up. The rates of levelling of scratches on copper electrodeposited at 10 amp/dm^2 and on the cast specimen with the surface deformed by machining, were about the same and faster than that of the scratch made on copper, electrodeposited at 0.5 amp/dm^2. In the second series of experiments, similar specimens were used which, however, had been given a four-hour anneal at 950°C before inscribing the scratches.
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The preliminary annealing slowed down the rate of levelling up of scratches during subsequent heating for all three specimens. The rate of self-healing of the scratch on copper electrodeposited at 10 amp/dm^2 remained faster than that for copper deposited at the lower current density. Since the density of electrodeposited metal decreases (in the case of thin deposits) with the distance from the first deposited layer, the object of the next series of experiments was to study the behaviour of scratches inscribed on the surface of copper electrodeposited to a thickness of 0.5, 1, 2 and 3 μ on annealed, copper strip cathodes. It was found that the thicker the deposit the faster was the rate at which the scratch levelled up on subsequent heating. Finally, it was found that (other factors being equal) the rate of levelling up of scratches inscribed on electrodeposited copper depended on the direction of the scratch relative to the direction of the current during electrodeposition. The results obtained are discussed in terms of the effect of structural defects on the self-diffusion mechanism of levelling up of the surface scratches. It is postulated that the experimental facts may be explained if it is assumed that side by side with surface diffusion, subsurface diffusion takes place in a

layer which is considerably thicker than the interatomic distance of the metal. The fact that the profile of the scratch remained smooth during the levelling up process in all the cases studied was attributed to small degree of anisotropy of the coefficient of surface tension of copper, and to the presence of misoriented elements of a dispersed structure in the surface layer. The results of the present investigation are in agreement with those obtained since by J.M.Blakely and H.Mykura (Ref.7: Acta met., 1961, 9, No.1, 23). There are 9 figures and 7 references: 5 Soviet and 2 non-Soviet. The two references to English language publications read as follows: Moore A.J.W., Acta met, 1958, 6, No.4, 293; Blakely J.M. and Mykura H. Acta met., 1961, 9, No.1, 23.

ASSOCIATION: Institut khimii KhGU Khar'kovskiy gosuniversitet
(Institute of Chemistry, KGU Khar'kov State University)

SUBMITTED: October 3, 1960

S/126/61/012/006/015/023
E021/E535

AUTHORS: Geguzin, Ya.Ye. and Paritskaya, L.N.

TITLE: Recrystallization in polycrystals with macroscopic pores

PERIODICAL: Fizika metallov i metallovedeniye, v.12, no.6, 1961, 900-907

TEXT: The influence of pores on recrystallization is of practical interest since components made by powder-metallurgical means often contain pores. Pores can also form during the process of creep of metals and alloys. The retarding influence of pores on the movement of grain boundaries is first discussed from a theoretical point of view. Results are then given of experiments carried out on porous brass from which the zinc had been partially removed at a high temperature, and on polycrystalline copper in which pores had been introduced by thermal cycling. The retardation of grain boundary movement by pores during recrystallization is shown by microphotographs of α-brass. The pores prevent the movement of the grain boundary in their immediate vicinity causing the grain boundary to become bent. The

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experiments on copper were more complete. Recrystallization of porous copper was carried out in an argon atmosphere. A polished surface was observed during recrystallization and microphotographs were taken at various stages. It is shown that the boundaries which are thickly populated with pores are extremely stable and do not migrate over long periods of time. The migrating boundaries are locked at pores and thus become bent. The observations agree with the theoretical expectation that, from energy considerations, a pore should be situated in a grain boundary and not within a grain. The effect of pressure was also studied, using samples of porous copper, the pores of which were mainly in the grain boundaries. Annealing was carried out in a water-cooled autoclave at a maximum pressure of 100 atm produced by argon. Under these conditions the number of pores decreased, and the average grain size increased with increase in pressure. There are 5 figures and 14 references: 9 Soviet-bloc and 5 non-Soviet-bloc. The four latest English-language references read as follows: Ref.2: Burke J.Trans.AIMME, 1949, 180, 73; Ref.3: Beck P., Holzworth M., Sperry P. Ibid, 163; Ref.7: Mullin W. W. J.Appl.Phys., 1957, 28, 333; Ref.8: Greenough A.P. Nature, 1950, 166, 904.

Recrystallization in polycrystals ... S/126/61/012/006/015/023
E021/E535

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet im. A. M. Gor'kogo
(Khar'kov State University imeni A. M. Gor'kiy)

SUBMITTED: March 20, 1961

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30715

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B104/B125

24.7100 1160 1454

AUTHORS: Geguzin, Ya. Ye., Ovcharenko, N. N., and Pavlitskaya, L. N.

TITLE: Interactions between vacancies and grain boundaries

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 141, no. 3, 1961, 603 - 606

TEXT: When studying the physical properties of polycrystals at high temperatures where the mobility of atoms and vacancies is very high, the interaction between vacancies and grain boundaries plays an important role. The authors investigated the grain boundaries as locations of prevalent condensation of excess vacancies and the formation of macroscopic pores and grain boundaries as preferred places for the discharge of excess vacancies from the boundaries of the polycrystal. It is assumed that pores located at grain boundaries will consist of two semi-pores. The profile of such pores is determined by the mutual orientation of grains and by the surface energy. The existence of surface energy between grains will change the equilibrium conditions along fracture lines of the pore profile, and this will cause pores to move along the boundaries (Fig. 1). To estimate the angular change of the fracture line of the pore profile, the relation $\sigma_{ik} = 2\sigma_0(\cos\bar{\alpha} - \cos\alpha)$

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Interactions between vacancies...

is introduced, where σ_0 denotes the surface energy at the boundary. The author finds the relation $\alpha^* = 2\frac{E_0}{\sigma_0}(A - \ln 2\alpha^*)$, where the point angle of the pore is zero, and obtains $\alpha^* \approx 20 - 30^\circ$. Here, $E_0 = Gb/4\pi(1-\nu)$; $A = 4\pi(1-\nu)B_k/Gb^2$, where G denotes the shear modulus, b the Burgers vector, ν Poisson's ratio, B_k the dislocation energy of a nucleus. This representation explains why grain boundaries partly free of pores can be observed in metallic polycrystals. The formation of grooves along grain boundaries at the crystallization boundary is ascribed to excess vacancies in polycrystals, which are due to various causes. The effect of the pores on the formation of grooves between grains is attributed to a coalescence process of the pores. This assumption is corroborated by various experimental data on the bulk distribution of grooves. There are 4 figures and 7 references: 4 Soviet and 3 non-Soviet. The two references to English-language publications read as follows: W. T. Read, W. Shochley, Phys. Rev., 78, no. 3 (1950); W. W. Mullins, J. Appl. Phys., 28, no. 3 (1957).

Card 2/3

Interactions between vacancies...

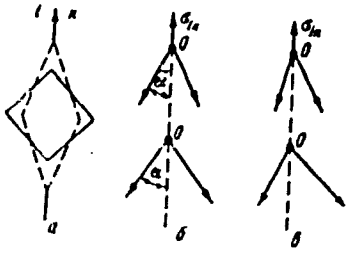
ASSOCIATION: Institut khimii Khar'kovskogo gosudarstvennogo universiteta im. A. M. Gor'kogo (Institute of Chemistry of Khar'kov State University imeni A. M. Gor'kiy)

PRESENTED: June 20, 1961, by P. A. Rebinder, Academician

SUBMITTED: June 12, 1961

Legend to Fig. 1: (a) Diagram of the change of the pore profile under the influence of an intermediate-phase surface energy; (b) pore located symmetrically to the boundary; (c) pore located asymmetrically.

Fig. 1



Card 3/3

32302
S/020/61/141/004/006/019
B102/B104

187510

AUTHORS: Geguzin, Ya. Ye., and Paritskaya, L. N.

TITLE: Effect of expansion of a localized porous zone in a crystalline body

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 141, no. 4, 1961, 833 - 835

TEXT: The authors theoretically and experimentally investigated the expansion of a porous zone in a metal when heated. The object under observation was a crystalline body consisting of a porous and a compact part, the latter surrounding the former. The process of coalescence was accompanied by a diffuse expansion of the porous zone with the internal energy of the system decreasing and its entropy increasing. From the thermodynamical standpoint this process was similar to the expansion of an ideal gas into the vacuum. It is theoretically described on the basis of formulas for the diffusion of vacancies (B. Ya. Pines, ZhETF, 16, 1, 1946). In the porous zone, the concentration of vacancies ξ is higher than the equilibrium concentration ξ_0, hence a vacancy flux will be

Card 1/3

Effect of expansion of a ...

observed through the interface between porous and nonporous zone, which is given by $j = -D_b \frac{\bar{\xi} - \xi_{o\sim}}{\bar{r}} - D_a \frac{2\sigma}{\bar{r}^2} \frac{\Omega}{kT}$ (σ - coefficient of surface tension, Ω - volume of an atom, D_b, D_a, - diffusion coefficients of vacancies and atoms, respectively, $\bar{r}$ - mean radius of the pores). New pores are formed on the vacancies diffused and, therefore, this process equals a shift of the interface into the compact zone. This effect differs from the diffusion effects which occur at the interface of two different metals as a result of the variety of the partial diffusion coefficients (Kirkendall effect, Frenkel' effect). A series of experiments were carried out to verify the theoretical results: Cylindrical samples of an initial porosity of 15% were molded from copper powder (grain size~50μ). They were annealed and, at the same time, partial sintering took place. Subsequently, they were molded in small copper tubes with the press plunger also consisting of copper, and the porous copper cylinder was entirely surrounded by nonporous metal. Then, the samples were subjected to heat treatment at two different temperatures

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Effect of expansion of a ...

and different holding times and, finally, the radial distributions of pores were examined metallographically. It became obvious that the pores primarily diffused into the nonporous metal along the grain boundaries, and that chains of pores were formed. After 50 hr holding at 1060°C, the copper jacket became completely porous. There are 4 figures and 8 references: 6 Soviet and 2 non-Soviet. The two references to English-language publications read as follows: R. Resnik, L. Seigle, J. of Met. 9, No. 1 (1957); A. Smigelskas, E. Kirkendall, Trans. AIME, T. P. 2071 (1946).

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet im. A. M. Gor'kogo (Khar'kov State University imeni A.M. Cor'kiy)

PRESENTED: June 20, 1961, by P. A. Rebinder, Academician

SUBMITTED: June 16, 1961

Card 3/3

PHASE I BOOK EXPLOITATION SOV/6339

Geguzin, Yakov Yevsayevich

Makroskopicheskiye defekty v metallakh (Macroscopic Defects in Metals) Moscow, Metallurgizdat, 1962. 252 p. Errata slip inserted. 5450 copies printed.

Ed.: A. K. Natanson; Ed. of Publishing House: Ye. N. Berlin; Tech. Ed.: L. V. Dobuzhinskaya.

PURPOSE: This book is intended for scientific and engineering personnel of metallurgical and machine-building plants and scientific research institutes. It may also be useful to students of schools of higher technical education specializing in the field of physics of solids.

COVERAGE: The book reviews theoretical and experimental studies of the mechanism and kinetics of processes taking place at high temperatures in metals with macrodefects (scratches, ridges, cracks, pores, etc.). Important characteristics of

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metals, such as heat resistance and rupture strength, are discussed. The author thanks S. Z. Bokshteyn, M. A. Krivoglaz, I. V. Smushkov, I. M. Lifshitz, and A. K. Natanson for their comments and assistance. There are 358 references: 218 Soviet and 140 non-Soviet.

TABLE OF CONTENTS:

S/120/62/000/001/013/061
E073/E335

AUTHORS: Goguzin, Ya.Ye. and Shpunt, A.A.

TITLE: Producing thin crystalline scintillating plates by the high-temperature forming method

PERIODICAL: Pribory i tekhnika eksperimenta, no. 1, 1962, 59 - 60

TEXT: In solving problems relating to spectroscopy of elementary particles the necessity arises of using very thin scintillating single crystals. The production of such thin films from massive single crystals by grinding involves considerable difficulties. The authors produced such films by hot-forming small pieces of CsI(Tl) single crystals in a press mould between two parallel plates at 500 - 600 °C. A load of about 0.5 tons was used for producing a 50 - 60 μ thick, 2 cm^2 film. The resulting films were optically transparent and did not suffer "ageing", which had been observed for thin plates produced by pressing finely-disperse powders. The energy

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Producing thin crystalline ....

resolutions of a typical series of thin CsI(Tl) films obtained in investigations with α-particles, E = 5.3 MeV (Po^{210}), were as follows:

No.	1	2	3	4	5	6	7	8	9	10
Film thickness, μ	100	80	100	80	110	100	120	90	90	90
Energy resolution, %	8.2	8	7.3	7.2	6.3	5.8	6	7	6	7.2.

The above data indicate that plastic deformation of a CsI(Tl) single crystal at an elevated temperature does not impoverish its scintillating properties and that the films are suitable for use as scintillators. There is 1 table.

Abstracter's note: this is a slightly abridged translation.

ASSOCIATION: Vsesoyuznyy nauchno-issledovatel'skiy institut monokristallov (All-Union Scientific Research Institute for Single Crystals)

Card 2/2

SUBMITTED: May 20, 1961

S/226/62/000/005/001/007
E202/E135

AUTHORS: Geguzin, Ya.Ye., and Ovcharenko, N.N.

TITLE: Microscopic pycnometry of solids with microcavities

PERIODICAL: Poroshkovaya metallurgiya, no.5, 1962, 15-19

TEXT: It is observed that instead of using the experimentally difficult and occasionally ambiguous method of low scattering of X-rays in determining the volume of discontinuities (cavities) Δ, where

$$\Delta = 1 - \frac{\rho_{pycn}}{\rho_{xray}} \qquad (1)$$

it is possible, when Δ is small, to use ordinary metallographic method as long as the samples are subjected to high temperature annealing prior to metallographic observation. The annealing causes diffusional coalescence of the cavities which increases the average cavity size. With cubic lattices, and certain other reservations it is possible to connect the pycnometric and X-ray porosity and the number of thermal treatment cycles (n) with the energy of vacancies formation U_o viz:

$$U_o = -KT \log \left[\frac{1}{n} \left(1 - \frac{\rho_{pycn}}{\rho_{xray}} \right) \right] \quad (5)$$

Using copper it was found that for $n = 50$ (with tempering from 650 °C), the number of pores $N \simeq 2.5 \times 10^6$ cm^{-3}, the average size of pores $L \simeq 2.7 - 3 \times 10^{-4}$ cm, i.e. $\rho_{pycn} = 0.999925\ \rho_{xray}$ and $U_o = 20 - 22$ kcal/mol. The above method is particularly suitable in studying the formation of friable electrolytic deposits and in other cases where there are small discrepancies between ρ_{pycn} and ρ_{xray}. There are 1 figure and 7 tables.

ASSOCIATION: Khar'kovskiy ordena Trudovogo Krasnogo Znameni gosudarstvennyy universitet im. A.M. Gor'kogo (Khar'kov Order of the Red Banner of Labour, State University imeni A.M. Gor'kiy)

SUBMITTED: February 5, 1962

S/226/62/000/005/002/007
E071/E435

AUTHORS: Geguzin, Ya.Ye., Paritskaya, L.N.

TITLE: On the diffusion coalescence of pores in crystalline bodies with a boundary network

PERIODICAL: Poroshkovaya metallurgiya, no.5 , 1962, 20-25

TEXT: Coalescence of pores was studied in polycrystals of electrolytic copper and of cast copper after first subjecting the latter to 100 cycles of heat treatment, quenching from 650°C in cold water. Specimens of porous copper (10 x 6 x 2 mm3) were annealed in a vacuo at 900, 1000 and 1050°C for various periods up to 27 hours. Then, the size distribution of pores was studied metallographically in arbitrary cross-sections of the specimens. For this purpose after each annealing treatment a layer of about 0.5 mm thick was mechanically removed from the surface of the specimen; according to control experiments the layer removal has no distorting effect on the distribution of pores. The effect of grain boundaries on coalescence of pores was studied by determining the time-dependence of the average size of pores both in the interior of the grains and at the grain boundaries. These

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On the diffusion ...

experiments were conducted on specimens given a preliminary stabilizing treatment as a result of which the total length of the grain boundaries remained practically constant during the experiments. The average size and the rate of growth of pores at the grain boundaries were somewhat greater than those of pores inside the grain boundaries. In addition, the time-dependence of the total length of the grain boundaries in unstabilized specimens was also determined. It is shown that at an early stage of annealing there is interaction between the boundaries and the pores; the stage of detachment of the boundaries from the pores is followed by a stage of transfer of a part of the pores to the boundaries which in time become stable. The experimentally observed coalescence of pores in its advanced stage can be described by the kinetic law previously established for single crystals: $\bar{R} \approx t^{1/3}$ (where $\bar{R}$ - mean pore size, t - time). In regions rich in pores, coalescence may not be accompanied by sintering - a decrease of the total volume of pores, taking place with the aid of the diffusion mechanism. There are 7 figures.

On the diffusion ...

S/226/62/000/005/002/007
E071/E435

ASSOCIATION: Khar'kovskiy ordena Trudovogo Krasnogo Znameni gosudarstvennyy universitet im. A. M. Gor'kogo (Khar'kov Order of the Red Banner of Labour, State University imeni A.M. Gor'kiy)

SUBMITTED: February 5, 1962

Card 3/3

GRGOZIN, Ya.Ye.; LIFSHITS, I.M.

Mechanism and kinetics of "healing" an isolated pore in a crystalline body. Fiz. tver. tela 4 no.5:1326-1333 My '62. (MIRA 15:5)

1. Khar'kovskiy gosudarstvennyy universitet imeni A.M. Gor'kogo.

(Diffusion)
(Crystal lattices)

43114
S/181/62/004/011/012/049
B102/B104

AUTHORS: Ceguzin, Ya. Ye., and N. N. Ovcharenko, N. N.

TITLE: Kinetics of thermal etching at interfaces of annealing twins in gold and copper

PERIODICAL: Fizika tverdogo tela, v. 4, no. 11, 1962, 3110 - 3116

TEXT: The kinetics of the development of "thermal-etching grooves" along the lines where the interfaces between coherent annealing twins and parent grains intersect the free grain surfaces were investigated experimentally. A theory for this process has been developed by W. W. Mullins (J. of Appl. Phys. 28, 3, 1957); see also J. of Appl. Phys. 22, 448, 1951; Phil. Mag., 6, 67, 937, 1961; Acta Metallurgica, 5, no. 6, 346, 1957; and Kristallografiya, 6, no. 1, 1961. The theory for the formation of symmetrical grooves is mentioned ($\beta' - \beta'' - \beta$; $\sigma_s' - \sigma_s'' - \sigma_s$). Anisotropy of σ_s is taken into account, and $\sigma_i = 2(\sigma_s \sin\beta - \partial\sigma_s/\partial\beta \cos\beta)$ (see Fig. 1). The results obtained by Mullins are used to calculate the rate at which a groove is deepened at the interface of twins

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Kinetics of thermal ...

$$h \simeq 10^{-1}\left(\frac{D_s \sigma_s \Omega^2 \nu}{kT}\right)^{1/4} t^{1/4}\left(\frac{\sigma_i + 2\left|\frac{\partial \sigma_s}{\partial \beta}\right|}{\sigma_s}\right), \quad (5),$$

where D_s is the surface diffusion coefficient, $\Omega = \delta^3$, δ is the lattice constant, $\nu = 1/\delta^2$ (surface density). Eq.(5) is valid for small angles of β. In general, grooves of various depths are formed along the lines where the interfaces of twins intersect the surfaces of the samples. If $\Delta h = h_2 - h_1$ and assuming $\cos\beta \simeq 1$ the following expression is obtained

$$\Delta h = \gamma \frac{1}{\sigma_s}\frac{\partial \sigma_s}{\partial \beta} t^{1/4}, \quad (7).$$

$$\gamma = 2B^{1/4} = 2\frac{D_s \sigma_s \Omega^2 \nu}{kT};$$

Experiments were made on very pure gold and copper samples. The shapes of the profiles were measured with an МИИ-4 (MII-4) microinterferometer. The annealing twins either were found to be symmetrical, i.e. the profile showed notches only, or they were antisymmetrical, i.e. the profile showed notches and cusps alternating. Such formations were observed in gold as well as in copper. Most of the investigations made with antisymmetrical twins were made with gold annealed at 950°C. The value for $\partial\sigma_s/\partial\beta$ amounted

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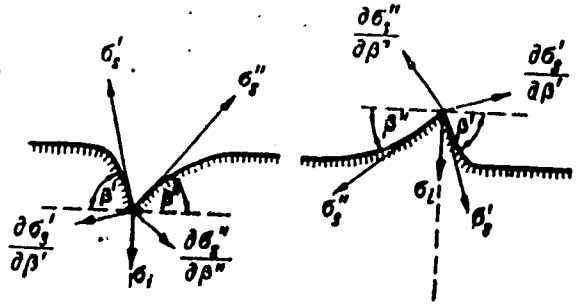
to 64 erg/cm^2, where σ_s - $1.4 \cdot 10^3$ erg/cm^2, δ - $4.07 \cdot 10^{-8}$ cm, D -4.10^{-5} cm^2/sec and T-950°C. The effective boundary energy $\sigma_i = \sigma_i + 2\partial\sigma_s/\partial\beta^s \cos\beta$ with $\cos\beta \simeq 1$ was found to be σ_i^* - 148 erg/cm^2, $\sigma_i - \sigma_i^* - 2\partial\sigma_s/\partial\beta \simeq 20$ erg/cm^2 and $\sigma_i/\sigma_s \simeq 0.014$, which agrees well with values from other authors. There are 7 figures.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet im. A. M. Gor'kogo (Khar'kov State University imeni A. M. Gor'kiy)

SUBMITTED: June 12, 1962

Fig. 1. Schematic drawing of the forces acting on a notch or cusp.



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43115
S/181/62/004/011/013/049
B104/B102

24.7500

AUTHORS: Gegusin, Ya. Ye., and Ovcharenko, N. N.

TITLE: The anisotropy of the coefficients of surface diffusion of metals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 11, 1962, 3117 - 3123

TEXT: A study is made of the influence which natural rugosities on the surface of crystals exert on the anisotropy of the coefficients D_s of surface diffusion. D_s was obtained from the smoothening, due to diffusion at 900°C, of the wedge-shaped scratch produced on the surface of polycrystalline samples of Cu, Fe and Au. To prevent the smoothening being affected by evaporation or by oxygen the samples were wrapped in foils of the same material and annealed in an atmosphere of dry hydrogen. The depth h of the wedge-shaped scratches was determined by an interferometric method.

$h = \frac{h_i}{d}\frac{\lambda}{2}$, where h_i is the interferometer depth of the scratch, d the distance between the interference lines and λ the wavelength. The scratch

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The anisotropy of the coefficients...

intersects the steps of the grain surface in the different grains of the polycrystal under different angles. Depending on the mutual positions of the scratch and the steps, the scratch has different depths for different times of annealing. The data show that the value of the self diffusion coefficient $D_{\parallel}$ along the steps of the crystals exceeds that of the coefficient $D_{\perp}$ perpendicular to the steps (Fig. 7) by 1.5 orders of magnitude. As a first possible cause of the difference, the relation between $D_{\perp}$ and the coefficients D_1 and D_2 of the two surfaces formed by the step is discussed. The existence of potential traps which increase the activation energy of diffusion in the corresponding direction is given as the second possible cause of the difference. For further clarification, the temperature dependence of $D_{\perp}$ and D_{π} is to be studied. There are 7 figures.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet im. A. M. Gor'kogo (Khar'kov State University imeni A. M. Gor'kiy)

SUBMITTED: June 12, 1962

S/070/62/007/006/010/020
E132/E435

AUTHORS: Goguzin, Ya.Ye., Koryakina, V.V., Kharitonova, L.S.

TITLE: Studies of processes on the surfaces of single crystals IV. High temperature processes on the surfaces of arbitrary sections of ionic crystals

PERIODICAL: Kristallografiya, v.7, no.6, 1962, 903-909

TEXT: Planes not naturally occurring were cut, by sawing followed by polishing, on single crystals of NaCl, KCl and LiF. They were cut corresponding to the planes (120), (130), (140), (150) and (180). Initially the planes were flat to the limits of the resolving power of the microinterferometric method. The specimens then underwent thermal treatment during which their surfaces were examined by the microinterferometer at intervals and the structure of the relief was determined. In the first series, specimens of NaCl were annealed in quartz ampules. At 780 and 750°C some loss of weight was observed. Asymmetric steps appeared having one large flat side and one steeper stepped escarpment. These were called the simple and complex slopes respectively. With time the character of the steps changed non-monotonically being sometimes

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diffuse and sometimes coarser. Five such alternations were observed for (120)-cut NaCl before a final shape resulted in which both slopes were 26°35' which is close to the angle of $\tan^{-1} 0.5$ which the (100) plane makes with the plane cut. If s_t is the surface energy of the initial surface then $s_t = s_s + s_c$ (s_s is the surface energy of the simple slope and s_c that of the complex slope). It has been shown that $s_t/s_c = \cos \beta$ where β is the angle of the complex slope. This ratio was plotted against time for each cut. In a second series heating took place in an isothermal enclosure where material which evaporated did not return to the surface. No diffuse stages were observed even for 50 hours of annealing. A further series checked that the transport of material occurred through the gas phase by noting the slowing which occurred when annealing was carried out under 80 atm of argon. There are 8 figures and 2 tables.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet, Vsesoyuznyy institut monokristallov (Khar'kov State University, All-Union Institute for Single Crystals)

SUBMITTED: December 28, 1961

S/126/62/013/002/006/019
E032/E314

18 8100

AUTHORS: Ratner, A.M. and Geguzin, Ya.Ye.

TITLE: Study of the origin of diffusion activity of crystalline bodies with defects. VI. On the effective diffusion coefficient in polycrystalline bodies

PERIODICAL: Fizika metallov i metallovedeniye, v. 13, no. 2, 1962, 214 - 218

TEXT: It is pointed out that the true diffusion coefficient should depend not only on the presence of a network providing paths of easy diffusion displacement of atoms but also on the presence of individual macroscopic defects such as pores and cracks. The authors discuss in the present paper the diffusion of matter (in the special case - a tracer isotope) in polycrystalline bodies with a developed network of intergrain separation boundaries. It is assumed for simplicity that the diffusion coefficient along these boundaries D_s is independent of the structural properties of the boundaries. Since this

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Study of the origin of ....

coefficient is assumed to be considerably greater than the body-diffusion coefficient D_V, the material diffuses mainly along the boundaries and only "leaks through" into the grains. Two limiting cases are examined, namely, $\Delta \gg \ell$ and $\Delta \ll \ell$, where ℓ is a characteristic linear dimension of a grain and Δ is the depth of penetration of the material into the body of the grain during a particular experiment. Expressions are derived for the effective diffusion coefficient of the polycrystalline body in terms of the statistical properties of the distribution of the above boundaries and the coefficient D_S.

An estimate is also made of the upper limit for the linear dimensions of a pore or crack, for which the effective diffusion coefficient remains unaffected.
There are 3 figures.

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Study of the origin of ....

S/126/62/013/002/006/019
E032/E314

ASSOCIATION: Vsesoyuznyy institut monokristallov i stsintillyatorov, Khar'kovskiy gosuniversitet (All-Union Institute of Single Crystals and Scintillators, Khar'kov State University)

SUBMITTED: March 27, 1961

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S/126/62/013/004/015/022
E111/E435

AUTHORS: Geguzin, Ya.Ye., Paritskaya, L.N.

TITLE: Inter-grain channels on the surface of a polycrystal with macroscopic defects in the structure (in porous bodies)

PERIODICAL: Fizika metallov i metallovedeniye, v.13, no.4, 1962, 591-598

TEXT: In defective-structure bodies the effects leading to normal formation at high temperatures of channels along grain boundaries can be intensified. With porous bodies the process can be complicated by the diffusion of vacancies from pores to the specimen surface along the grain boundaries. Modern views are that boundaries play a very important part in the compacting of porous bodies and suggest that sintering is accompanied by intensive development of inter-grain channels. This effect of pores can also be considered as being a pore-coalescence effect. The object of the present work was to check the correctness of those views and to confirm them qualitatively, thereby obtaining additional information on the peculiarities of diffusion processes

Card 1/2

Inter-grain channels ...

in bodies with macroscopic defects (particularly in powder compacts). The interferometric method was used to study qualitatively the kinetics of inter-granular channel development on copper specimens with various pore-type defects. Specimens wrapped in copper foil were annealed in hydrogen at 800°C. For an evaluation of the kinetics the authors extend the treatment of W.W.Mullins (J. Appl. Phys., v.28, no.3, 1957) to porous bodies, taking into account the additional diffusion of vacancies from pores. They show that the effective diffusion coefficient for the process is 20 to 30 times greater than the coefficient of surface diffusion: this is in line with other observations, such as the disappearance of surface scratches. Sintering can be explained in terms of surface channel development (through the arrival of vacancies) and disappearance. There are 7 figures.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet
Institut khimii KhGU (Khar'kov State University
Chemistry Institute KhGU)

SUBMITTED: July 17, 1961

Card 2/2

S/053/62/076/002/003/004
B117/B104

AUTHORS: Geguzin, Ya. Ye., Ovcharenko, N. N.

TITLE: Surface energy and processes on the surface of solids

PERIODICAL: Uspekhi fizicheskikh nauk, v. 76, no. 2, 1962, 283 - 328

TEXT: This is a survey on progress achieved in the investigation of processes taking place on the surface of single solids which are in equilibrium with their own vapors. The survey comprises studies dealing with the following problems: Method of determining the surface energy of solids; "natural roughness" of crystal surfaces; variation of the surface profile of single crystals and polycrystals, development of intergranular thermal etching grooves; liquid films on the surface of crystalline bodies. Finally it is pointed out that further studies must be undertaken and a few problems are posed whose solution is of great importance for the development of this branch of solid-state physics, e. g., working out experimental methods for determining the surface energy of solids; study of processes taking place on the surface of solid alloys; effect of gases dissolving on the surface, on surface tension. Apart from being

Card 1/2

of purely scientific interest, studies of surface processes may also be of great practical importance. This refers above all to the possibility of producing perfect surfaces by applying the so-called "thermopolishing", a procedure which produces a smooth flawless surface by applying high temperatures without necessitating special treatment. V. D. Kuznetsov, I. V. Obreimov, Ye. S. Trekhov, I. M. Lifshits, V. N. Slezov, A. A. Chernov, P. I. Lukirskiy, G. G. Lemmleyn, M. O. Kliya, I. A. Oding, M. G. Lozinskiy, S. E. Khaykin, N. P. Bene, Ye. D. Dukova, A. I. Bublik, B. Ya. Pines, L. S. Palatnik, Yu. F. Komnik, A. V. Shubnikov, K. Mazanets, Ye. Kamenskaya, M. G. Shaskol'skaya, I. M. Lifshits are mentioned. There are 37 figures, 5 tables, and 127 references: 64 Soviet and 63 non-Soviet. The four most recent references to English-language publications read as follows: John p. Gilman, Direct Measurements of the surface energies of crystals. J. Appl. Phys. 31 (2), 2208 (1960); R. Euernsey and J. Gilman, Proc. Soc. Exper. Stress Anal. 1960; H. Mykura, The variation of the surface tension of nickel with crystallographic orientation. Acta Metallurgica 9 (6), 570 (1961); J. M. Blakely, H. Mykura, Surface self diffusion measurements on nickel by the mass transfer method, Acta Metallurgica 9 (1) (1961).

Card 2/2

GEGUZIN, Ya. Ye.

"Behavior of Isolated Porosity in Crystals at High Temperatures under the Effect of Gas Pressure."

TITLE: The Sixth All-Union Conference on Powder Metallurgy (Held at Moscow, 21 November 1962

SOURCE: Poroshkovaya metallurgiya, no. 3, 1963. p. 110

GEGUZIN, Ya.Ye.; RABETS, V.L.

Study on crystal ceramics. Part 3. Izv. vys. ucheb. zav.; fiz. no. 4:106-112 '63. (MIRA 16:9)

1. Khar'kovskiy gosudarstvennyy universitet i Vsesoyuznyy nauchno-issledovatel'skiy institut monokristallov.
(Ceramics)

S/181/63/005/003/029/046
B102/B180

AUTHORS: Geguzin, Ya. Ye., and Dzyuba, A. S.

TITLE: Interaction of macroscopic pores in a solid

PERIODICAL: Fizika tverdogo tela, v. 5, no. 3, 1963, 891-896

TEXT: The authors consider two relatively large pores close to one another and calculate the possible distortions of the stress and diffusion fields caused by their interaction, and assess the kinetics of the processes accompanying the approach of their centers. This was experimentally studied with macroscopic pores 10^{-1} - 10^{-2}cm diam in artificial NaCl crystals grown by the Stokbarger method. Samples with suitable, close, pores of equal size were selected and studied under the microscope. The pores were healed by heating in an autoclave (argon 20-30 kg/cm^2, 700-750°C). The experimental results are plotted as $l/l_o = f(d/d_c)$, where $l=L+2R$ is the distance between the pore centers and $d=2R$, the pore diameter. The experimental values lie on the theoretical

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curves, calculated from $v \simeq \frac{R^2\dot{R}}{(L+R)^2} = \frac{\dot{R}}{(1+L/R)^2}$, where v is the rate with which the pore centers approach. There are 5 figures.

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AUTHORS: Geguzin, Ya. Ye.; Kovalev, G. N.

TITLE: Investigation of diffusion on the surface of polycrystalline metals

SOURCE: Fizika tverdogo tela, v. 5, no. 6, 1963, 1687-1696

TOPIC TAGS: surface diffusion, Ag, Ni, Au, dislocation, oxidation-reduction, "laminated sample", vacancy

ABSTRACT: The authors have made use of a method previously advanced by them (Ya. Ye. Geguzin, G. N. Kovalev, and A. M. Ratner, FMM, 10, 1, 1960)--the "laminated sample" method--to investigate surface diffusion in the systems Ag*-Ag, Ag*-Ni, and Ag*Au (the asterisks representing the diffusing component). The coefficients of surface diffusion they obtained are shown in the following expressions:

$$D_{Ag^*-Ag} = 0.3 \exp\left(\frac{-11\,800}{RT}\right).$$

$$D_{Ag^*-Ni} = 22.4 \exp\left(\frac{-16\,000}{RT}\right).$$

The authors determined the thickness of the surface layer in which diffusion takes place to be on the order of 10-20 atomic layers. They discuss several possible

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