PA 75T96

LYUBOV, B. YA.

May 1948

USSR/Physics
Heat-Transmission
Heat - Convection

"On V. L. Shevel'kov's Article, 'Calculation of the Temperature Field in an Isotropic Medium in Front of a Moving Source of Heat'," B. Ya. Lyubov, Inst of Metallophysics, Cen Sci Res Inst of Ferrous Metal, 3 pp

"Zhur Tekh Fiziki" Vol XVIII, No 5

The correct solution of the equation $\frac{\partial t}{\partial \theta} = a\frac{\partial^2 t}{\partial x^2}$ when $\theta > 0$; $x > \xi(\theta)$ is $x = \xi(\theta) = c_a\theta + \frac{c_a}{P}$ not $\xi(\theta) = h - c_o\theta$ as stated by Shevel'kov.

75T96

[redacted]

LIUBOV, B.Ya.

Computing the rate of growth of ferrite grains following the isothermal decomposition of austenite. Dokl. AN SSSR 60 no.5: 795-797 My '48. (MIRA 10:8)

1. Otdel teoreticheskoy fiziki Instituta metallofiziki TSentral'nogo Nauchno-issledovatel'skogo instituta chernoy metallurgii. Predstavleno akademikom I.P. Bardinym.

(Ferrite (Steel constituent))
(Austenite)

LYUBOV, B.Ya., kand.fiz.-mat.nauk

Calculating the growth rate of a ferrite nucleus during isothermal dissociation of austenite. Probl.metalloved.i fiz. met. no.[1]:316-321 '49. (MIRA 11:4)

1.Otdel teoreticheskoy fiziki TSentral'nogo nauchno-issledovatel'skogo instituta chernoy metallurgii.
(Ferrite (Steel constituent))
(Metal crystals)

1

Met. Abs.

Determination of the Coefficient of Diffusion at Low Concentrations of the Diffusing Substance. B. Ya. Lyubov (*Doklady Akad. Nauk S.S.S.R.*, 1949, 68, (6), 1117–1120).—[In Russian]. Two specimens of a solid soln. of different concentration were placed end to end to form a compound specimen. If, after annealing at a definite temp. for a fixed time, the concentration of solute in both parts of the compound specimen is measured, the coeff. of diffusion can be expressed as a function of concentration of solute at a given temp. At low concentrations of solute, the relation is linear: $D = D_0 + \alpha c$. The method of determining the coeff. of diffusion at a given temp. for low solute concentrations is refined by solving the equation, $\frac{\partial}{\partial x}\left(D_0 + \alpha c\right)\frac{\partial c}{\partial x} = \frac{\partial c}{\partial t}$ under given limiting conditions. By math. treatment the equation is brought into a form which will give a theoretical value of the concentration of solute in both parts of the compound specimen. This is compared with some experimental values in the case of the diffusion of C into Fe at 1198° C. for 61·5 hr., and is found to agree extremely well.—Z. S. B.

Comments and evaluation B-78524, 8 Sep 54

Inst. of Metal Studies and Physics of Metals, Central Sci-Res. Inst of Ferrous Metal.

LYUBOV, B. YA.

Lyubov, B. Ya. Calculation of the rate of hardening of a metallic ingot. Doklady Akad. Nauk SSSR (N.S.) 68, 847–850 (1949). (Russian)

Solidification (crystallization) of a slab of material of uniform thickness and with insulated edges is considered, with special attention given to the progress of the front of crystallization into the slab. The material is first considered liquid with its temperature at the freezing point. A boundary value problem is then set up, involving the heat equation, the variable surface temperature, the temperature at the moving front of crystallization $y(\tau)$ and a relation expressing the heat balance at $s=y(\tau)$. After a change of variables, $\xi=1-s/y(\tau)$, a solution of the form $V(\xi,\tau)=\sum_{n=0}^{\infty}a_n(\tau)\xi^n$ is assumed. A recursion formula for $a_n(\tau)$ is then found, after which use of the surface condition $V(1,\tau)=f(\tau)$, and some manipulation of series, gives $y(\tau)$ as a series involving $f(\tau)$. Proof of convergence of the resulting series is left to be considered for each special function $f(\tau)$. The result for $f(\tau)=$constant is expressed in closed form. [The sign in equation (4a) is in error, but a second error made in transforming to (4b) corrects it.]

R. E. Gaskell (Ames, Iowa)

Source: Mathematical Reviews, Vol 11 No. 1

PA 164T57

USSR/Metals - Pearlite

Jul 50

"Theory of Pearlite Growth," B. Ya. Lyubov, Inst of Metallophys, Cen Sci Res Inst of Ferrous Metals

"Zhur Tekh Fiz" Vol XX, No 7, pp 872-879

Presents mathematical physical study of concentrations C of carbon in austenite, pearlite, etc., (C_a, C_s, C_f, C_p, C_{ac}, etc.) as functions of V (atomic volume of carbon), T, rho (radius of curvature of interphase surface). Sets up two-dimensional partial differential equation describing diffusion (C vs x,y,t; D: diffusion

164T57

USSR/Metals - Pearlite (Contd)

Jul 50

coefficient of carbon in austenite; S_o: periodic interplastic distance in pearlite). Submitted 3 Mar 49.

164T57

LYUBOV, B. YA.

(1)-RMZ

The influence of the stresses arising in the disintegration of solid solutions on the rate of growth of the nuclei of a new phase. B. Ya. Lyubov. *Zhur. Tekh. Fiz.* 20, 1344-52 (1950); ~~Chem. Zentr.~~ 1951, II, 490; cf. *C.A.* 47, 9126g, 10305g.—Calcns. are reported which show that stresses arising from transitions in structure in the system Fe-C accelerate the growth of the ferrite grains. It is assumed that the stresses developing in the growth of the nuclei of the new phase lie within the elastic limit. Under the influence of these stresses the max. of the curve showing the rate of growth of the nuclei is raised considerably and displaced to lower temps. M. G. Moore

11-26-54

LYUBOV, B. YA.

①-RMF

Rate of Growth of the Nucleus of a New Phase During the Isothermal Decomposition of a Solid Solution. B. Ya. Lyubov. (*Doklady Akad. Nauk S.S.S.R.*, 1950, 72, (2), 273–276; *C. Abs.*, 1950, 44, 10426).—[In Russian]. A theoretical expression was derived to account for a slower rate of growth of small nuclei than that given by the diffusion rate of the solute. This slow rate is especially noticeable in the pptn. of a new phase from a supercooled hypoeutectoid solid soln. having a different compn. and structure. Two processes are necessary for the growth of such nuclei: re-formation of the solute lattice and movement of solute atoms across the nucleus interface. In the initial stage of nucleus growth, when its size is just above the critical size, change in the solvent occurs slowly and the solute concentration at the surface of the nucleus is almost unchanged. However, the equilibrium concentration of such a nucleus is large. At this stage the rate of growth is wholly determined by the kinetics of lattice deformation. Beyond a critical nucleus size the rate of growth is determined by diffusion.

11-23-54 RMF

Inst. of Metal Studies + Physics of Metals, TsNIIChM.

IA 172T91

USSR/Physics - Steel 21 Oct 50

"Influence of Concentration Stresses Upon the Speed of Lateral Growth of the Pearlite Grain," L. I. Aleksandrov, B. Ya. Lyubov, Inst of Metal Studies and Phys of Metals, Cen Sci Res Inst of Ferrous Metallurgy

"Dok Ak Nauk" Vol LXXIV, No 6, pp 1081-1084

Math treatment of diffusion eq to clarify comparatively great speeds of decay of solid soln for temp where speed of normal diffusion is small. Submitted 22 Jul 50 by I. P. Bardin.

[redacted] 172T91

Evaluation B-78945, 15 Sep 54

ALEKSANDROV, L.N.; LYUBOV, B.Ya., kand. fiz.-mat. nauk.

Effect of concentration stresses on the rate of pearlite grain edge growth. Probl. metalloved. i fiz. met. no.2:256-270 '51.
(Steel--Metallography) (Strains and stresses) (MIRA 11:4)

2

Kinetics of isothermal growth of the martensite crystal. B. Ya. Lyubov. *Doklady Akad. Nauk S.S.S.R.* 78, 905-8(1951).—A theoretical analysis is made of Kurdyu-mov's mechanism of martensite formation (cf. *Zhur. Tekh. Fiz.* 18, 999(1948)). If the martensite crystal has the form of a doubly-concave lens with $H \ll R$, where H is the max. thickness and R is the radius, the vol. of the crystal is $\pi HR^2/3$ and the surface area is $2\pi R^2$. The elastic stress in the crystal causes a displacement of the surface layers pro-portional to ϕ times the thickness of the crystal, where ϕ de-pends on crystallographic factors. The elastic deforma-tion about the crystal is on the order of H/R, and if the vol. affected is $4\pi R^3/3$, then the elastic energy is on the order of $\gamma\pi RH^2$, where $\gamma = \phi^2G/8$ and G is the shear modulus. The total change of free energy, ΔF, as the result of forming a martensite crystal is: $\Delta F = (-\Delta F_v \pi R^2H/3) + \sigma 2\pi R^2 + \gamma\pi RH^2$, where ΔF_v is the free-energy change accompanying the transformation of a unit vol. of austenite to martensite, and σ is the surface energy. The most probable relative dimensions of the martensite crystal, found by setting $d\Delta F = 0$ for const. vol., are $R = 3\gamma H^2/4\sigma$. Expressions for the rate of radial growth, v_R, and of growth in thickness, v_H, are derived and their ratio is $v_R/v_H = 2\sigma/3\gamma H$, which has a max. value $\leq 2\sigma/3\gamma H_{min}$ at $H = H_{min} = 16\sigma/3\Delta F_v$. The rate of radial growth is always the greater. After the breaking of coherency between the austenite and martensite the radius of the martensite crystal remains const. at its final value, R_0. The thickness may increase to the equil. value $\Delta F_v R_0/4\gamma$ if ΔF decreases. Since ΔF_v increases with decreasing temp., so does the equil. thickness. This effect has been reported by Kurdyumov. In most cases plastic deformation occurs before the equil. thickness is achieved and prevents the change in size. A. G. Guy

Inst. Metallography + Physics of Metals

LYUBOV, B.Ya., redaktor; MIKHAYLOVA, V.V., tekhnicheskiy redaktor

[Problems of metallography and the physics of metals; third collection] Problemy metallovedeniia i fiziki metallov; tretii sbornik trudov. Moskva, Gos. nauchno-tekhn. izd-vo lit-ry po chernoi i tsvetnoi metallurgii, 1952. 384 p. [Microfilm] (MLRA 7:10)

1. Moscow. TSentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii.
(Metallurgy) (Metallography)

LYUBOV, B. YA.

USSR/Metals - Steel, Structural Analysis Apr 52

"The Field of Stresses Originating During the Decomposition of a Solid Solution Near the Spherical Nucleus of the New Phase," L. N. Aleksandrov, B. Ya. Lyubov, Inst of Metal Studies and Phys, TsNIIChM (Cen Sci Res Inst of Ferrous Metallurgy)

"Dok Ak Nauk SSSR" Vol LXXXIII, No 6, pp 833-835

Analyzes effect of stresses, caused by decompn of solid soln, on growth rate of new-phase nucleus and applies results obtained to calcn of stresses induced in supercooled austenite ($T = 993^{\circ}$ K) of hypoeutectoid concn around sepg ferrite grain. Submitted by Acad I. P. Bardin 29 Feb 52.

223T48

1. [illegible], B. Ya.

2. USSR (600)

4. Diffusion

7. Determination of the diffusion coefficient D = Dc + [illegible]. Dokl. AN SSSR 84, no. 1, 1952. Institut Metallovedeniya i Fiziki Metallov TsNIIChM Rec'd. [illegible] Feb. 1952

9. Monthly List of Russian Accessions, Library of Congress, September 1952, UNCLASSIFIED.

USSR.

Calculation of the Rate of Growth of the Nucleus of a New Phase in a Phase Transformation in a One-Component System. B. Ya. Lyubov (*Doklady Akad. Nauk S.S.S.R.*, 1952, 84, (2), 277–279).—[In Russian]. L. had previously shown (*ibid.*, 1950, 72, 273; *M.A.*, 20, 1006) that the rate of growth is determined by the relation $dn/dt = -n^*\nu(e^{-U/kT}/kT)\cdot(d\Delta F_n/dn)$, where n and n^* are the numbers of atoms contained in the nucleus and situated next to the phase boundary, resp., ν is the frequency of vibration of the atoms, U the energy of activation of the process, and ΔF_n the change in energy of the supercooled system on the appearance in it of a nucleus of the new phase contg. n atoms. With a spherical nucleus of radius ρ, if d is the at. dia., ΔF_0 the change in free energy for conversion of unit vol. from the old phase to the new, and σ the surface energy, then $d\rho/dt = B(1 - \rho_c/\rho)$, where $\rho_c = 2\sigma/\Delta F_0$ and $B = (\nu d^4 \Delta F_0/kT)\cdot e^{-U/kT}$. By considering the thermal effects at the phase boundary, L. also derive

USSR/Metals - Structural Analysis Jun 52

"Influence of the Concentration Stresses on the Diffusion Processes in Solid Solutions," B. Ya. Lyubov, N. S. Fastov, Inst of Metal Studies and Phys of Metals

"Dok Ak Nauk SSSR" Vol LXXXIV, No 5, pp 939-941

Using phenomenological method, develops eq of diffusion which takes into consideration elastic stresses caused by nonuniform distribution of dissolved substance in solid soln. These stresses, decreasing with equalization of concn affect diffusion process, sometimes to such an extent that

223T54

disregarding them may result in considerable discrepancy between calcd and exptl data. Submitted by Acad I. P. Bardin 12 Apr 52.

223T54

LYUBOV, B. YA.

PA 239T62

USSR/Engineering - Heat, Processes Aug 52

"Heating Lump Materials Under Conditions of Counter flow," G. P. Ivantsov and B. Ya. Lyubov, Cen Sci Res Inst of Ferrous Metallurgy

"DAN SSSR" Vol 85, No 5, pp 993-995

Develops soln of problem posed as follows: load of balls of given dia and initial temp moves at steady rate down shaft of given height and cross-section; gas of definite initial temp is blown upward through shaft; it is required to find temp field in single ball as function of time, and

239T62

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variation in gas temp along shaft. Equations obtained permit to calc heat exchange in blast furnaces with greater precision then could be done by approx method previously developed by B. I. Kitayev. Submitted by Acad I. P. Bardin 19 Jun 52.

239T62

LYUBOV, B. YA.

LYUBOV, B. Ya.

235T106

USSR/Physics - Heat Conduction 11 Sep 52

"Initial Heating of Immobile Layer of Spheres by a Current of Hot Gas," G. P. Ivantsov, B. Ya. Lyubov, Cen Sci Res Inst of Ferrous Metallurgy

"Dok Ak Nauk SSSR" Vol 86, No 2, pp 293-296

Discusses soln of the problem concerning the initial heating of the layer of lumpy material by means of a current of hot gases, taking into account the temp drop with respect to thickness of the piece. Sets up the eqs involving radius of spheres, initial temp, temp of gas, velocity of

235T06

the gas, cross section for the gases, etc. Solves by means of Laplace transformations. Submitted by Acad I. P. Bardin 8 Jul 52.

235T106

LYUBOV, B. Ya.

Dissertation: "The Theory of Isothermic Phase Conversions of Metals and Alloys." Dr Phys-Math Sci, Khar'kov State U, Khar'kov, 1953. (Referativnyy Zhurnal--Khimiya, Moscow, No 10, May 54)

SO: SUM 318, 23 Dec 1954

LYUBOV, B. YA.

USSR.

The theory of the determining stage in the decomposition
of supersaturated solid solutions. B. Ya. Lyubov and B. I.
Maksimov. *Zhur. Tekh. Fiz.* 23, [illegible] The de-
compn. of supersatd. solid solns. is discussed theoretically
from the standpoint of deviations in the concn. from the av.
value in a certain small vol. of the soln. A very small,
initial inhomogeneity of concn. is sufficient to cause signif-
icant local deviations from the av. concn. The tensions
caused by these deviations allow a rearrangement of the lat-
tice of the solid soln. to form a new phase. J. R. L.

Lyubov, B. Ya.

USSR.

532.782

3179. The nonsteady rate of nucleation of a new phase under great supercooling. B. YA. LYUBOV. Dokl. Akad. Nauk SSSR, 91, No. 2, 243-6 (1953) In Russian. English translation, U.S. National Sci. Found. NSF-tr-109.

A non-stationary, initial solution is found for the Smoluchowski-type "diffusion" equation of phase nucleation. It is assumed that (a) supercooling is great enough for the thermodynamic barrier term to be neglected; (b) the relation $D = kTB$ remains valid when the "mobility" (B) is a function of the "co-ordinate." The result is a nucleation rate proportional to $t^{1/4}$, which may well explain the existence of an incubation period.

R. O. DAVIES

LYUBOV, B.Ya.

(2)

Metallurgical Abst.
Vol. 21 May 1954
Structure

*The Effect of Plastic Deformation Arising During Decomposition of a Solid Solution on the Rate of Growth of a Nucleus of the New Phase. L. N. Aleksandrov and B. Ya. Lyubov (*Doklady Akad. Nauk S.S.S.R.*, 1953, 91, (3), 519-522).—[In Russian]. Math. Equations are developed for the rate of growth of spherical nuclei from supersaturated solid soln. which take into consideration the effect of plastic deformation, and they are applied to isothermal growth of ferrite from austenite. The chief conclusion reached is that the stresses set up by the transformation cause the process to be autocatalytic. 6 ref. (Translated by the U.S. National Science Foundation (NSF-tr-95)).—D. M. P.

Inst. Metal Studies + Physics of Metals, TsNIIChM

LYUBOV, B. Ya.

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*Computation of the Rate of Solidification of an Ingot, Taking into Account the Temperature-Dependence of the Thermophysical Parameters of the Metal. B. Ya. Lyubov. (*Doklady Akad. Nauk S.S.S.R.*, 1953, 92, [redacted] [In Russian]. A formula for the rate of advance of the crystn. front during the solidification of a metal ingot on the assumptions that the thermal conductivity, λ, and the heat capacity, c, of the solid metal are related to the temp. by equations of the resp. forms $\lambda = \lambda_0 + \mu T$ and $c = c_0 + \omega T$ is derived. The theory is applicable to cases in which the dependence of λ and c upon T is not necessarily linear. The theory is illustrated by consideration of the crystn. of an Al ingot. In this case, the error attributable to ignoring the temp.-dependence of λ and c is shown to be small and negligible, but the error due to omission to take account of such dependence may be substantial in the case of metals of high m.p. (Translated by the National Science Foundation, Washington (NSF-tr-227)).—J. S. G. T.

Inst. of Metal Studies & Physics of Metals, TsNIIChM.

LYUBOV, B. Ya.

(Boris Yakovlevich)

"Theory of Isothermal Phase Transformations in Metals and Alloys," (Dissertations), Academic Degree of Doctor in Physiomathematical Sciences, based on his defense, 27 February 1954, in the Council of Khar'kov State U im. Gor'kiy.

Central Sci Res Inst of Ferrous Metallurgy.

M- 3,054,778, 2 Oct 57

HUME-ROTHERY, William; LYUBOV, B.Ya., redaktor [translator]; SELISSKIY, Ya.P., redaktor [translator].

[Atomic theory for students of metallurgy. Translated from the English] Atomnaia teoriia dlia metallurgov. Perevod s angliiskogo i redaktsiia B.IA.Liubova i IA.P.Selisskogo. Moskva, Gos.nauchno-tekhn.izd-vo lit-ry po chernoi i tsvetnoi metallurgii, 1955. 332 p. (MLRA 9:4)

(Atomic theory) (Electrons) (Metals)

LYUBOV, B.Ya.,redaktor;BEKKER, O.G., tekhnicheskiy redaktor.

[Problems of physical metallurgy and the physics of metals; fourth collection of papers] Problemy metallovedeniia i fiziki metallov; chetvertyi sbornik trudov. Moskva, Gos.nauchno-tekhn.izd-vo lit-ry po chernoi i tsvetnoi metallurgii, 1955. 6?0 p. (MLRA 8:9)
(Metallurgy)

Evaluation B-97978, 13 Jul 56

USSR/Solid State Physics - Diffusion, Sintering, E-6

Abst Journal: Referat Zhur - Fizika, No 12, 1956, 34750

Author: Borisov, V. T., Lyubov, B. Ya.

Institution: None

Title: On the Theory of the Method of Determining the Diffusion Coefficient from the Boundaries of the Grains of Metals

Original Periodical: Fiz. metallov i metallovedeniye, 1955, 1, No 2, 289-302

Abstract: Mathematical foundation and a refinement are given for the method of determining the diffusion coefficient from the boundaries of grains of metals, based on the Fisher model (Fisher, I. C., Jr. Appl. Phys., 1951, 22, 74).

LYUBOV, B. YA.

Category : USSR/Solid State Physics - Phase Transformation in Solid Bodies E-5

Abs Jour : Ref Zhur - Fizika, No 3, 1957, No 6616

Author : Lyubov, B.Ya.
Title : Theory of the Growth of Centers of a New Phase in Isothermal Decomposition of Austenite.

Orig Pub : Tr. Nauch.-tekhn. o-va chernoy metallurgii, 1955, 3, 39-44

Abstract : A theoretical analysis has been made of the growth of centers of a new phase in the isothermal decomposition of supercooled austenite. The new phase (ferrite, cementite or pearlite) differs from the initial one (austenite) both in its structure as well as in its composition. Consequently, the redistribution of the dissolved matter combines in the phase transition with the transition of the solvent from one structural form to another. The kinetics of the process of the growth of the center are determined by which of the particular components of its simple processes causes a minimum rate of displacement of the boundary between the phases. Thus, for example, a schematic analysis of the growth of the ferrite center (Dokl AN SSSR, 1952, 84, 277) shows that

Card : 1/2

LYUBOV, B.YA.

USSR/Crystals. B-5

Abs Jour : Referat Zhur - Khimiya, No 6, 1957, 18306

Author : B.Ya. Lyubov, B.I. Maksimov.

Title : Theory of Determination Methods of Concentration Dependence of Diffusion Factors in Solid Solutions.

Orig Pub : Probl. metalloved. i fiz. metallov, sb.4, 1955, 543-569

Abstract : The theory of a new method to determine the dependence of the diffusion factor D on the concentration c is given. A special method to determine D = f(c) by means of radioactive indicators is developed. It is shown by examples that in case of thick layers, the new method yields results close to results yielded by Matano's method, and that the usual methods of determination of D with radioactive indicators yield values of D close to the mean values in the concentration interval in question.

Card 1/1

KAMENETSKAYA, D.S., kandidat fiziko-matematicheskikh nauk; LYUBOV, B.Ya., kandidat fiziko-matematicheskikh nauk; ROSENBERG, V.M., kandidat tekhnicheskikh nauk.

"Metallography." S.S.Shteinberg. Reviewed by D.S.Kamenetskaia, B.IA.Liubov, V.M.Rozenberg. Stal' 15 no.1:95-96 Ja '55. (MLRA 8:5)

1. Organizatsiya VNITOM pri TsNIIChM.
(Metallography) (Physical metallurgy) (Shteinberg, S.S.)

LYUBOV, B. YA.

USSR/Physics - Martensite transformations

Card 1/1 Pub. 22 - 18/51

Authors : Lyubov, B. Ya., and Osipyan, Yu. A.

Title : On the kinetics of isothermal martensite transformation near absolute zero

Periodical : Dok. AN SSSR 101/5, 853-856, Apr. 11, 1955

Abstract : Experiments with martensite transformations are described. The experiments were conducted to determine that the phase transformations of martensite at temperatures near absolute zero do not depend on the temperature, but to the speed of such transformation and that it is a function of the energy of atomic fluctuations. Seven references: 1 British, 2 USA and 4 USSR (1935-1953). Table; graph.

Institution : Central ~~Scientific-Research~~ Institute of Ferrous Metals, Institute of Metallography and Physics of Metals

Presented by : Academician G. V. Kurdyunov, January 1, 1955

L 41384-66 [illegible]

ACC NR: AP6018526 SOURCE CODE: UR/0181/66/008/006/1683/1689

AUTHOR: Lyubov, B. Ya.; Solov'yev, V. A.

ORG: Central Scientific-Research Institute of Ferrous Metallurgy im. I. P. Bardin, Moscow (Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii)

TITLE: Kinetics of disintegration of dislocation cracks on the polygonal walls of edge dislocations

SOURCE: Fizika tverdogo tela, v. 8, no. 6, 1966, 1683-1689

TOPIC TAGS: crystal dislocation phenomenon, crystal defect, crack propagation, metastable state, surface property, relaxation process, brittleness, hardening

ABSTRACT: The authors analyze the decay of metastable dislocation cracks on polygonal walls of edge dislocations, the decay being the result of diffusion over the surface of the crack. It is pointed out in the introduction that formation of dislocations along one side of a crack is energetically favored and that the diffusion on the surface of the crack is the more likely mechanism of disappearance of dislocation cracks at low temperatures. The time evolution of the diffusion of the atoms over the surface of the crack from the base of the crack, which is under compression, into the mouth of the crack, which is under tension, is described and the dislocation distribution produced during such an evolution is calculated. The decrease in volume accompanying the crack disintegration is also calculated as well as the relaxation times characterizing the process. It is concluded that dislocation cracks should

L 31224-66

ACC NR: AP6018526

disintegrate as a result of diffusion on the vertical polygonal walls of its dislocations, with a decay time that depends strongly on the number of dislocations forming the crack. This disintegration probability is the cause of the experimental difficulty of observing microcracks. The process counteracts the development of cracks and consequently prevents brittle failure. The effect of this process on hardening produced by heat treatment is briefly mentioned. Orig. art. has: 24 formulas and 2 figures.

SUB CODE: 20/ SUBM DATE: 13Oct65/ ORIG REF: 003/ OTH REF: 004

Card 2/2

LYUBOV, B. YA.

4
1-4E2c

*The Determination of the Coefficients of Volume- and Grain-Boundary-Diffusion of Metals. V. T. Borisov, V. M. Golikov, and B. Ya. Lyubov (*Izvest. Akad. Nauk S.S.S.R.*, 1956, [Tekhn.], (10), 37-47).—[In Russian]. The absorption method was used. The relative change of the integral activity is greater at higher temp. This is satisfactorily explained by theory and makes possible an analysis of the distribution of diffusion. The diffusion curves show three stages: (1) with a small gradient; (2) with a greater gradient; and (3) a smaller gradient again. In the first stage, there is a simultaneous transport of material both within the grain and across the grain boundary. The change in concentration (and hence the slope of the curve) is determined by the diffusion within the crystal, the magnitude of which is much greater than that by grain-boundary diffusion. Thus there is an increase in vol. at the part of the crystal adjacent to the surface layer, which results in a decrease of diffusion within the crystal. The diffusion through the boundaries is as before. At this stage the rate of change of concentration is determined by complex factors. The transition from the first to the second stage is slow for low temp. In stages (2–3), all the transported material is absorbed through the grain boundary, and the rate of change of concentration is again dependent on the coeff. of vol. diffusion; it is greater at higher temp. 8 ref.—N. E. B.

LYUBOV, B.Ya.; ROYTBURD, A.L.

Unsteady period in the nucleation of new phase centers during isothermal phase transformations in a single-component system. Dokl. AN SSSR 111 no.3:630-633 N '56.

(MLRA 10:2)

1. Institut metallovedeniya i fiziki metallov TSentral'nogo nauchno-issledovatel'skogo instituta chernoy metallurgii. Predstavleno akademikom G.V. Kurdyumovym.

(Phase rule and equilibrium)

Lyubov B. Ya.

137-1958-2-2486

Translation from Referativnyy zhurnal. Metallurgiya, 1958, Nr 2, p 42 (USSR)

AUTHOR: Lyubov, B. Ya.

TITLE: Physicomathematical Methods for Analyzing the Kinetics of the Solidification and Formation of the Structure of a Metal Ingot (Fiziko-matematicheskiye metody analiza kinetiki zatverdevaniya i formirovaniya struktury metallicheskogo slitka)

PERIODICAL: V sb. Fiz.-khim. osnovy proiz-va stali. Moscow, AN SSSR, 1957, pp 739-748. Diskus. pp 781-791

ABSTRACT: An effort was made by means of mathematical analysis to solve the problem of the kinetics of the solidification of an ingot from the point of view of the heat exchange, also the problem of the solidification of an ingot when account is taken of the physicokinetic factors which make it possible to compute the different crystalline structures in the ingot. It was concluded from the calculations that the effect of supercooling the metal in order to advance the front of acicular crystallization was small, that the initially significant supercooling on the crystallization front rapidly diminished and attained values of the order of 2-3°, that the temperature of the molten metal rapidly approached the temperature of the

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137-1958-2-2486

Physicomathematical Methods for Analyzing the Kinetics (cont.)

crystallization front, and that after the start of crystallization in depth (which led to the formation of a zone of equiaxial crystals in the ingot) the supercooling in the liquid phase was considerably less than on the crystallization front. This theory requires that the mechanisms of heat transfer and crystallization be defined more precisely and that account be taken of the three-dimensionality of the crystallization process.

V.N.

1. Ingots--Solidification 2. Ingots--Structural analysis 3. Ingots--Mathematical analysis

Card 2/2

137-58-6-13268

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 6, p 300 (USSR)

AUTHORS: Maksimova, O.P., Golovchiner, Ya.M., Lyubov, B.Ya., Nikonorova, A.I.

TITLE: Fundamental Trends in Investigations of the Theory of Martensite Transformation (Osnovnyye napravleniya issledovaniy v oblasti teorii martensitnykh prevrashcheniy)

PERIODICAL: Sb. tr. In-t metalloved. i fiz. metallov Tsentr. n.-i. in-ta chernoy metallurgii, Trans. Amer. Soc. Metals, 1957, Nr 49, pp 427-444. Discuss. 1958, Vol 5, pp 147-160

ABSTRACT: Fundamental problems of the study of laws governing the martensite transformation (MT), the effect of various factors on it, and the control of the process of MT, also means and methods for the investigation of MT are formulated. Bibliography: 80 references.

L.V.

1. Martensite--Analysis 2 Martensite--Theory 3. Metals--Transformations

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"Calculation of the Temperature Range and Rate of Shift of the Front of a Phase Transformation in Spherical Bodies," with Temkin, D. Ye., page 311.

In book Problems of Physical Metallurgy, Moscow, Metallurgizdat, 1958, 603p. (Its: Sbornik trudov, v. 5)

The articles in the book present results of investigations conducted by the issuing body, Inst. of Physical Metallurgy, a part of the Cent. Sci. Res. Inst. of Ferrous Metallurgy, located in Dnepropetrovsk. The investigations were concerned with phase transformations in alloys, strengthening and softening processes, diffusion processes (studied with the aid of radioactive isotopes), and certain other questions.

AUTHOR: Gulyayev, B.B. SOV/24-58-4-37/39

TITLE: Conference on Crystallisation of Metals (Soveshchaniye po kristallizatsii metallov)

PERIODICAL: Izvestiya Akademii Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk, 1958, Nr 4, pp 153 - 155 (USSR)

ABSTRACT: This conference was held at the Institut mashinovedeniya AN SSSR (Institute of Mechanical Engineering of the Ac.Sc. USSR) on June 28-31, 1958. About 400 people participated and the participants included specialists in the fields of foundry, metallurgy, crystallography, physics, welding, heat, physical chemistry, mathematical physics and other related subjects. In addition to Soviet participants, foreign visitors included Professor D. Czikl (East Germany) and N.I. Chvorinov (Czechoslovakia). This conference on crystallisation of metals was the fourth conference relating to the general problem of the theory of foundry processes.

Conference on Crystallisation of Metals SOV/24-58-4-37/39

General Problems of Crystallisation of Metals

Member of the Ac.Sc. Belorussian SSR N.N. Sirota, in his paper "On the Mechanism of the Process of Crystallisation", proposed a general physico-mathematical theory on germination and the growth of crystals and described its application to problems of crystallisation of metals.

Corresponding Member of the Ac.Sc. Ukrainian SSR K.P. Bunin and Yu.S. Taran, in their paper "Eutectic Crystallisation of Grey Irons", considered the features of formation of graphite separations in eutectic alloys from the point of view of the general theory of crystallisation of iron.

B.Ya. Lyubov, in his paper "Calculation of the Speed of Solidification of Metals in Large Volumes", proposed a synthesis of the molecular-kinetic and of the thermal theories of crystallisation of metallic castings.

A.G. Spasskiy, in the paper "Fundamental Factors Influencing the Structure of Castings" and M.V. Mal'tsev in the paper "Methods of Improving the Quality of Cast Metal", described results of their investigations of crystallisation of castings from various alloys and considered methods of controlling such processes.

I.L. Mirkin dealt with the influence of fluctuations in the concentration on the formation of crystallisation nuclei and formation of crystals in complex alloys.

G.P. Ivantsov gave a review of the present concepts on germination and the growth of crystals. O.N. Magnitskiy, A.A. Demidova and B.B. Gulyayev considered the influence of the speed of crystallisation and the composition of the alloys on the quantitative characteristics of the structure and the mechanical properties of castings of the systems iron-carbon and aluminium-silicon. D.S. Kamenetskaya, N.P. Rakhmanova and Ye.Z. Spektor dealt with the results of investigation of the kinetics of crystallisation of iron and its alloys. G.F. Balandin proposed a mathematical theory of formation of the structure of castings and applied it for elucidating the features of crystallisation of iron. Ya.V. Grechnyy dealt with the features of crystallisation of binary alloys of various types.

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SOV/137-58-7-15651

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 7, p 248 (USSR)

AUTHOR: Lyubov, B. Ya., Roytburd, A. L.

TITLE: On the Speed of Nucleation of a New Phase in Single-component Systems (O skorosti zarozhdeniya tsentrov novoy fazy v odnokomponentynkh sistemakh)

PERIODICAL: Sb. tr. In-ta metalloved. i fiz. metallov Tsentr. n.-i. in-t chernoy metallurgii, 1958, Vol 5, pp 91-123

ABSTRACT: The nonstationary process of nucleation (N) is analyzed theoretically. At a constant temperature the rate of N can be considered independent of time and calculated according to the formula: $J_{st} = K_{1e} - \Delta\ \Phi_k/RT-u/RT$ only after the lapse of a certain amount of time from the beginning of the isothermal soaking [time of the nonstationary state (TS)]. On the basis of the solution of the kinetic equation describing the nonstationary N process, an evaluation of TS during phase transformation in single-component systems is made. The deductions of the general theory are applicable to the investigation of transformations in the solid state, which proceed without changes in the chemical composition of the phases. The TS is

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SOV/137-58-7-15651

On the Speed of Nucleation of a New Phase (cont.)

$<10^{-7}-10^{-10}$ sec for processes with a low activation energy (AE) (martensite transformation) but can be considerable (commensurable with the time of complete transformation) in processes with AE close to the AE of self-diffusion (normal polymorphic transformations). Therefore the N process with martensite transformation may be regarded as stationary. The application of a stationary expression for the rate of N in the case of normal polymorphic transformation might lead to considerable errors and demands a preliminary evaluation of TS. Bibliography: 36 references.

L. V.

1. Alloys--Transformations 2. Nuclear physics--Applications

Card 2/2

MAKSIMOVA, O.P., kand.tekhn.nauk; GOLOVCHINER, Ya.M.; LYUBOV, B.Ya., doktor fiz.-mat.nauk; NIKONOROVA, A.I., kand.tekhn.nauk

Basic trends in research on the martensite transformation theory. Probl. metalloved. i fiz. met. no.5:147-160 '58. (MIRA 11:4)
(Phase rule and equilibrium) (Martensite)

SOV/137-58-11-23356

Translation from: Referativnyy zhurnal. Metallurgiya, 1958, Nr 11, p 216 (USSR)

AUTHOR: Lyubov, B. Ya.

TITLE: A Theory on the Growth of New-phase Centers During Phase Transformations in a Single-component System (Teoriya rosta tsentrov novoy fazy pri fazovykh prevrashcheniyakh v odnokomponentnoy sisteme)

PERIODICAL: Sb. tr. In-t metalloved. i fiz. metallov Tsentr. n.-i. in-ta chernoy metallurgii, 1958, Vol 5, pp 294-310

ABSTRACT: A theoretical analysis of the process of growth of new-phase centers during phase transformations in a single-component system. By employing the methods of the thermodynamics of unbalanced conditions and the theory of the absolute reaction rates, the author derives a formula for the rate of growth of a new-phase center under isothermal conditions as a function of its radius. The growth of a new phase is also examined by taking into consideration the temperature variations on the phase boundaries resulting from the liberation of the latent heat of fusion. The results of the theory are applied to an analysis of polymorphous and martensitic transformations. The role of

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SOV/137-58-11-23356

A Theory on the Growth of New-phase Centers During Phase Transformations (cont.)

quantum effects was investigated with particular emphasis on the tunnel effect during the growth of a martensite crystal at low temperatures. Bibliography: 21 references.

A. R.

Card 2/2

SOV/137-58-9-19809

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 9, p 242 (USSR)

AUTHORS: Lyubov, B.Ya., Temkin, D.Ye.

TITLE: Calculation of the Temperature Field and the Rate of Displacement of a Phase-transformation Front in Spherical Bodies (Raschet temperaturnogo polya i skorosti peremeshcheniya fronta fazovogo prevrashcheniya v sfericheskikh telakh)

PERIODICAL: Sb. tr. In-t metalloved. i fiz. metallov Tsentr. n.-i. in-ta chernoy metallurgii, 1958, Vol 5, pp 311-316

ABSTRACT: Starting with the equations for thermal conductivity the authors determine the temperature field in a solid phase and formulate an expression for the law governing the growth, as a function of time, of the region occupied by a solidifying melt contained within a spherical volume of a liquid phase that is maintained at the temperature of crystallization, T_k; at the initial instant the surface of the sphere is cooled below T_k, while the solid phase is absent entirely. A method which has been developed earlier is employed (RZhFiz, 1956, Nr 4, abstract 10468). Equations for the time of the beginning and the end of the process are derived. V.R.

1. Metals--Transformations

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Vol 5, pp 317-326

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A Theoretical Analysis of the Effect of Alloying (cont.)

providing the diffusion of the alloying element itself does not retard the process. Critical dimensions were established for a nucleus, determined primarily by the diffusion process. The time required for completion of T's with various mechanisms was expressed analytically as a function of temperature. A formula for determination of the nucleation rate of a new phase is given. In the case of nonalloyed austenite, the mechanism of lattice modification gains in importance as the temperature is reduced; at temperatures below 600°C this mechanism becomes a determining factor. At temperatures above 650° the mechanism of diffusion of C is of predominant importance. The process of diffusion of C determines the rate of T in non-alloyed steels and in steels containing alloying elements which noticeably inhibit the diffusion process (Cr, Mo). In the case of steels alloyed with elements that have a small tendency to retard the diffusion of C (Mn, Ni, W), or which tend to accelerate it, the process of modification of the Fe lattice becomes a decisive factor.

V.R.

1. Austenite--Transformations 2. Alloys--Metallurgical effects 3. Metallurgy --Theory

Card 2/2

SOV/137-58-9-19818

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 9, p 244 (USSR)

AUTHORS: Aleksandrov, L.N., Lyubov, B.Ya.

TITLE: A Theoretical Analysis of the Effect of Alloying on the Kinetics of Isothermal Decomposition of Austenite (Teoreticheskiy analiz vliyaniya legirovaniya na kinetiku izotermicheskogo raspada austenita)

PERIODICAL: Sb. tr. In-t metalloved. i fiz. metallov Tsentr. n.-i. in-ta chernoy metallurgii, 1958, Vol 5, pp 317-326

ABSTRACT: The rate of growth of nuclei of a new phase was determined as a function of time. The rate of nucleation was taken to be constant at a given temperature. The rate of growth is a function of the mechanism of phase transition within a given range of dimensions of the growing nucleus of a new phase. By employing the equation for the volume of a new phase during phase transformations (T) and by utilizing results previously obtained regarding the growth of a spherical nucleus [B.Ya. Lyubov, DAN (Dokl. AN), 1950, Vol 62, p 273], it is shown that, depending primarily on the mechanism of the T, the alloying either expands or reduces the range of dimensions of the nucleus,

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SOV/137-58-9-19818

A Theoretical Analysis of the Effect of Alloying (cont.)

providing the diffusion of the alloying element itself does not retard the process. Critical dimensions were established for a nucleus, determined primarily by the diffusion process. The time required for completion of T's with various mechanisms was expressed analytically as a function of temperature. A formula for determination of the nucleation rate of a new phase is given. In the case of nonalloyed austenite, the mechanism of lattice modification gains in importance as the temperature is reduced; at temperatures below 600°C this mechanism becomes a determining factor. At temperatures above 650° the mechanism of diffusion of C is of predominant importance. The process of diffusion of C determines the rate of T in nonalloyed steels and in steels containing alloying elements which noticeably inhibit the diffusion process (Cr, Mo). In the case of steels alloyed with elements that have a small tendency to retard the diffusion of C (Mn, Ni, W), or which tend to accelerate it, the process of modification of the Fe lattice becomes a decisive factor.

V.R.

1. Austenite--Transformations 2. Alloys--Metallurgical effects 3. Metallurgy --Theory

Card 2/2

Lyubov B. Ya

30-1-13/39

AUTHOR: Shvartsman, L. A., Doctor of Chemical Sciences.

TITLE: The Practice of the Application of Isotopes for Technical Purposes (Iz praktiki primeneniya izotopov v tekhnike).

PERIODICAL: Vestnik AN SSSR, 1958, Vol. 28, Nr 1, pp. 79-83 (USSR)

ABSTRACT: The majority of reports delivered at the Paris Conference in 1957 dealt with problems of metallurgy. The Polish authors T. Mal'kevich and R. Vuzatovskiy used the radioactive isotopes Fe^{59} for the explanation of the distribution of non-metallic inclusions in a steel block, which get into the liquid metal during casting from the refractory materials. For this purpose iron oxide which was enriched by Fe^{59} was introduced into the raw clay from which the bricks for the lining of the casting device were made. After casting the ingots and blooms were autoradiographed, and besides the radioactive intensity of radiation of the metal was measured. These experiments were also carried out with various refractories in order to determine their influence. The Soviet metal experts V. T. Borisov, V. M. Golikov, B. Ya. Lyubov, and G. V. Shcherbedinskiy in their report dealt with problems of diffusion in real metals, which have a polycrystalline structure. A. A. Zhukhovitskiy, M. Ye. Yanitskaya, and A. D. Sotskov reported on the results of the

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Metallography

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Stressed [illegible]tates in Austenite in the Vicinity of a Formed Martensite Crystal

SUBMITTED: February 28, 1958

1. Austenite--Stresses 2. Martensite crystals--Metallurgical effects 3. Stress analysis 4. Mathematics

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18(0) PHASE I BOOK EXPLOITATION SOV/2125

Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii. Institut Metallovedeniya i fiziki metallov

Problemy metallovedeniya i fiziki metallov (Problems in Physical Metallurgy and Metallophysics) Moscow, Metallurgizdat, 1959. 540 p. (Series: Its: Sbornik trudov, 6) Errata slip inserted. 3,600 copies printed.

Additional Sponsoring Agency: USSR. Gosudarstvennaya planova komissiya.

Ed. of Publishing House: Ye.N. Berlin; Tech. Ed.: P.G. Islent'yeva; Editorial Board: D.S. Kamenetskaya, B.Ya. Lyubov (Resp. Ed.), Ye.Z. Spektor, L.M. Utevskiy, L.A. Shvartsman, and V.I. Malkin.

PURPOSE: This book is intended for metallurgists, metallurgical engineers, and specialists in the physics of metals.

COVERAGE: The papers in this collection present the results of investigations conducted between 1954 and 1956. Subjects

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covered include crystallization of metals, physical methods of influencing the processes of crystallization, problems in the physical chemistry of metallurgical processes, development of new methods and equipment for investigating metals, and production control. References follow each article.

TABLE OF CONTENTS:

PART I. CRYSTALLIZATION OF METALS

The results of measuring the supercooling of steels lead to the conclusion that the energy of nucleation in type-Kh18N9 austenitic steel is much greater than in type-Kh27 ferritic steel. This explains the difficulty of refining the grain of ingots of Kh18N9 steel by means of additions of titanium and boron, as well as the ease of refining the gain of Kh27

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steel with the aid of seed crystals. It was shown that modifying additions of titanium and boron diminish the capacity of Kh23N18 steel for significant supercooling. Titanium and boron, at concentrations which produce minimum supercooling of the melt, refine the dendritic structure at rapid rates of solidification.

Neymark, V.Ye., and A.I. Dukhin. Effect of Modifying Agents on the Structure, Skin Deformation, and Solidification Rate of Steel Ingots 39

Skin defects were revealed in ingots of four types of steel (St. 3, Kh27, Kh23N18, and Kh18N9) by the vacuum-crystallization method. It was found that modifying agents (titanium, zirconium, and boron) reduce skin deformation and accelerate the skin-solifidication rate of these steels in varying degrees. The results obtained suggest that it would be advisable to investigate the possibility of using modifying agents for lessening skin deformation and increasing the skin-solidification rate in the continuous casting of steel.

Problems in Physical Metallurgy (Cont.) SOV/2125

Kamenetskaya, D.S., Candidate of Physical and Mathematical Sciences; E.P. Rakhmanova; Ye.Z. Spektor; and V.I. Shiryayev. The Mechanism of the Effect of Aluminum on the Formation of Crystallization Centers in Liquid Iron

Liquid primary iron (electrolytic and direct-reduction) containing no active undissolved impurities or surface-active dissolved impurities can easily be supercooled 260-270° C, below the melting point. Nonactivated particles of Al_2O_3 have little effect on the development of crystallization centers in iron. But the start of the crystallization process in iron containing particles of Al_2O_3 has an activating effect on the particles and results in a decrease in supercooling capacity. The introduction of small quantities of aluminum into iron sharply reduces the supercooling capacity. The small degree of supercooling in such cases is in accord with the fact that additions of aluminum to steel act to refine the grain. In view of the results of this investigation and others, this effect may be explained by the fact that small additions of aluminum decrease the energy of nucleation in liquid iron. Because of the surface activity of aluminum, nucleation can take place spontaneously with but slight supercooling, as a result of which a fine-grained cast structure is obtained.

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Problems in Physical Metallurgy (Cont.) SOV/2125

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Leont'yev, V.I. Effect of Ultrasonic Waves on the Crystallization of Ingots

For effective passage of ultrasonic waves through molten metal it is necessary to establish a definite limit of specific ultrasonic power. The time necessary for action of the waves on the molten metal must exceed a certain minimum, but at the same time need not be as great as that required for complete solidification. Better results are obtained with the use of wider ingot molds and slower cooling. Ultrasonic waves induce intensive crystallization in all directions from numerous nuclei, the formation of which is aided by the action of the waves.

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The application of elastic vibrations during crystallization results in a marked refinement of the grain. The linear dimensions of the grains are 3-5 times smaller than those of ordinary grains. Columnar crystals are almost entirely lacking. In addition, nonmetallic inclusions are relatively small and uniformly distributed. The mechanical properties of both types of steel are improved.

This method is recommended for the production of high-quality thin-walled ingots (blanks). In cases where the blanks are long and thich-walled, or short and thin-walled, the centrifugal-casting method is preferred. The vacuum-crystallization method is still in the experimental stage, but is already being used at several Soviet machine-building plants for producing hollow cylindrical blanks from nonferrous metals and alloys.

Yemyashev, A.V.; A.M. Zubko, Candidate of Physical and Mathematical Sciences; and V.Ye. Neymark. On the Effect of Vacuum Melting and Teeming on Metal Properties and Ingot Quality 1[illegible]

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The content of nitrogen and hydrogen in metal melted in an atmosphere of argon at a pressure of 1-450 mm. Hg has little relationship to the pressure of the argon and is considerably lower than in the original charge. The inert gas must be purified of oxygen if a pressure is used at which the partial pressure of oxygen would exceed 0.01 mg. Hg. The same applies to nitrogen contained in the inert gas, provided the nitrogen reacts with the metal.

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Problems in Physical Metallurgy (Cont.)

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PART II. PHYSICAL CHEMISTRY OF METALLURGICAL PROCESSES

Tomilin, I.A., Candidate of Technical Sciences, and L.A. Shvartsman, Doctor of Chemical Sciences. Effect of Silica, Calcium Oxide, and Sodium Oxide on the Distribution of Sulfur and Phosphorus in Iron and Ferruginous Slag 199

It was found that the heat of transfer of sulfur from iron to slag in the system $FeO-SiO_2$, saturated with silica, is decreased by the addition of CaO to the slag. At a concentration of about 20 percent CaO the heat of reaction amounts to some 13,000 cal./g. atom, which coincides with the heat of transfer of sulfur from iron to ferruginous slag. Further, on increasing the content of CaO in the slag, a certain increase in entropy takes place. An overall result of these processes is a reduction in the value of the coefficients of sulfur distribution in comparison with acid slag not containing CaO. The introduction of Na_2O into the slag causes the same phenomenon to take place, but in a greater degree. These

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facts may be explained by the specific interaction of ions in the acid fusion. The free energy of solution of solid iron sulfide in ferruginous and ferruginous-silicate slags was calculated. It was shown that the heat of transfer of phosphorus from iron to acid slag does not differ from the corresponding figure in the case of ferruginous slag. The coefficients of diffusion of phosphorus, however, are considerably less in the first case than in the second. This can be explained by the presence of a "structure" of silicate polymers in the acid slag. Additions of CaO and Na_2O to acid slag increase the heat of reaction of dephosphorization, and at the same time the values of the coefficients of distribution rise.

Kozhevnikov, I.Yu., Candidate of Technical Sciences, and L.A. Shvartsman. Effect of Oxides of Alkali Earth Metals on the Equilibrium of the Dephosphorization Reaction of Iron 221

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Vintaykin, Ye.Z. Methods of Determining Vapor Pressure Over Metals and Alloys 293

Malkin, V.I. Measurement of Crystallization Rates in Slags of the System $CaO-Al_2O_3-SiO_2$ 306

For two slags of this system a determination was made of the relationship between temperature and rate of crystallization in the temperature range of the vitreous state. Within a narrow temperature range this relationship can be described by a simple exponential law. Determinations were also made of the energy of activation of the rate of crystallization. The high value of the energy of activation for slag consisting of 23 percent CaO, 18 percent Al_2O_3, and 59 percent SiO_2 (66,000 k cal./mol) as compared with that for slag consisting of 23 percent CaO, 32 percent Al_2O_3, and 45 percent SiO_2 indicates the presence of cationic aluminum in these slags.

The distribution process was studied with the use of a radioactive isotope (Ca^{45}). It was shown that the process of diffusion of a substance in slag takes place at a considerably slower rate than in metal.

Shvartsman, L.A., A.I. Osipov,, V.I. Alekseyev, V.F. Surov, M.L. Sazonov, M.T. Bul'skiy, S.A. Telesov, A.M. Skrebtsov, A.M. Ofengenden, L.G. Gol'dshteyn, and F.F. Sviridenko. An Investigation of the Kinetics of Scrap Melting in the Scrap-Ore Process 326

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Stupar', S.N. Investigation of the Transfer of Sulfur from the Gas Phase to the Bath in the Basic Open-hearth Furnace 344

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metallic portion of the charge. The speed of sulfur absorption during this period is 17-25 percent per hour, during pre-heating 8-11 percent, and during final melting 3-7.5 percent. Percentage is based on the sulfur content in the metal.

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Kornev,Yu.V., Candidate of Physical and Mathematical Sciences. A Simple Electronic Magnetic Spectrometer for Identifying Radioactive Isotopes 481

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Tokmakov, V.S. Experience Gained in the Use of Gamma-ray Flaw-detection Method in Metallurgy 537

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A160/A101

AUTHORS: Lyubov, B. Ya., Temkin, D. Ye.

TITLE: The theory of crystallization in large volumes

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 6, 1962, 4, abstract 6I25 ("Sb. tr. In-t metalloved. i fiz. metallov Tsentr. n.-i. in-ta chernoy metallurgii", v. 6, [illegible], 84 - 99)

TEXT: A calculation was made of the solidification rate of a metal ingot with consideration of undercooling. Crystallization processes for two boundary cases were considered: for a case of total intermixing and for a case of heat exchange in the melt by heat conductivity. It is shown that the undercooling at the front of the crystallization quickly decreases as it proceeds and soon diminishes to a minimum after the beginning of the process. From an analysis of the equations obtained it is concluded that the overheat gradually abates during the solidification process of the ingot and that the remaining liquid proves to be undercooled at the given moment. Due to this fact, new centers of crystallization may arise. The results of the work permit the explanation of the pre-

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APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031220004-8"

S/137/62/000/006/089/163
A160/A101

The theory of crystallization in large volumes

...ance of three zones in the ingot: the zone of a thin seam of fine equiaxial crystals, the columnar zone, and the central zone of equiaxial crystals.

P. ...vasilyenko

[Abstracter's note: Complete translation]

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SOV/126-8-2-10/26

AUTHORS: Aleksandrov, L.N. and Lyubov, B.Ya.

TITLE: Contribution on the Influence of Alloying on the Kinetics of the Pearlite Transformation

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 8, Nr 2, pp 216 - 224 (USSR)

ABSTRACT: Considerable differences of opinion exist (R.I. Entin et al - Refs 1-4) on the reasons for the influence of alloying elements on the kinetics of the pearlite transformation in austenite. This transformation, the authors point out, is important not only in eutectoidal but also in hyper- and hypo-eutectoidal steels since the excess ferrite (or cementite) liberated in the early stages of the transformation leads to the attainment of the eutectoidal state. To elucidate the influence of alloying elements the relation between the rate of formation of centres of the new phase, the lateral rate of growth of the pearlite grain, the alloying element concentration and the transformation temperature were studied. The authors use available information (Ya. S. Umanskiy et al - Refs 6-8) to discuss these relations.

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They consider the movement of the austenite/pearlite boundary, ignoring its curvature, obtaining an equation from which the rate of growth of a pearlite grain in the eutectoidal transformation of both unalloyed and alloyed steel; the equation, unlike previous ones (Refs 4,9) has no constants determined from rates found experimentally. As a first approximation, the authors assume that the change of activation energy for the $\gamma \rightarrow \alpha$ iron transformation on alloying corresponds to the change of that of the self-diffusion. From their equation the authors conclude that alloying can reduce the rate of rearrangement of the iron lattice to such an extent that it becomes rate-controlling. To calculate the rate of growth of pearlite grains depending on diffusion of carbon in alloyed austenite, the authors use their previous (Ref 12) results, allowing for the considerable influence

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of concentrating strains on diffusion. Calculated values of pearlite-transformation rate are close to or considerably higher than experimental for unalloyed or chromium steel, respectively. A form of the diffusion equation is solved by the authors in their previous manner (Ref 12) to give relations for pearlite-growth rate in the formation of ferrite-carbide mixture where this is limited by diffusional redistribution of the alloying element in austenite. They conclude that this could not be the rate-controlling factor for chromium, nickel, manganese and some other alloying elements with a high activation energy of diffusion, but could be for elements such as molybdenum. The authors then deduce kinetic equations for the pearlite transformation for control by iron-lattice rearrangement, by carbon diffusion and alloying element diffusion. They calculate kinetic curves for 50% transformation of austenite in unalloyed (Figure 1) and alloyed (0.4% C, 8.5% Cr) steel and consider a steel with 0.5% Cr and 0.4% C; then compare

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calculated and experimental results. With over 2.5% Cr, the pearlite transformation rate is governed by the polymorphic transformation. Their results show that the views of Frye, Stansbury McElroy (Ref 9) that the rearrangement mechanism is rate controlling in eutectoidal unalloyed steel are incorrect. There are 2 figures and 18 references, of which 14 are Soviet and 4 English.

ASSOCIATION: Mordovskiy gosudarstvennyy universitet (Mordovskiy State University)
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SUBMITTED: June 14, 1958

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PHASE I BOOK EXPLOITATION SOV/4344

Soveshchaniye po teorii liteynykh protsessov, 4th

Kristallizatsiya metallov; trudy soveshchaniya (Crystallization of Metals; Transactions of the Fourth Conference on the Theory of Casting Processes) Moscow, Izd-vo AN SSSR, 1960. 325 p. 3,200 copies printed.

Sponsoring Agency: Akademiya nauk SSSR. Institut mashinovedeniya. Komissiya po tekhnologii mashinostroyeniya.

Resp. Ed.: B. B. Gulyayev, Doctor of Technical Sciences, Professor; Ed. of Publishing House: V. S. Rzheznikov; Tech. Ed.: S. G. Tikhomirova.

PURPOSE: This book is intended for metallurgists and scientific workers. It may also be useful to technical personnel at foundries.

COVERAGE: The book contains the transactions of the Fourth Conference (1958) on the Theory of Casting Processes. [The previous 3 conferences dealt with hydrodynamics of molten metals (1955), solidification of metals (1956), and shrinkage processes in castings (1957)]. General problems in the crystallization of metals, including the crystallization of constructional steels,

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APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031220004-8"

alloy steels with special properties, cast iron, and of nonferrous alloys, are discussed. Recognition is given to D. K. Chernov and N. T. Gudtsov and their students, B. B. Gulyayev and A. G. Spasskiy, for their contributions to the understanding of the basic problems involved in the theory of crystallization of ferrous and nonferrous metals and alloys. Academician A. V. Shubnikov is also mentioned in connection with his work on the planning of research on crystal formation. References accompany several of the articles.

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AUTHORS: Lyubov, B.Ya. and Fastov, N.S.

TITLE: On the Problem of Diffusion in a Plastically Deformed Medium

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol. 10, No. 2, pp. 310 - 312

TEXT: The work of S.A. Dovnar (Ref. 1) and Yu.P. Romashkin (Ref. 2) is said to contain errors. Moreover, these workers did not take into account the possible variation of the diffusion coefficient D with time. Simmons and Dorn (Ref. 3) have obtained a diffusion equation which is not subject to the latter limitation, although their method is unnecessarily involved and difficult to understand. The present authors report a clearer derivation of the diffusion equation for a plastically deforming medium and indicate the method whereby this equation can be solved. Let $\vec{j}$ be the flow density of the diffusing substance, $\vec{v}$ the velocity of displacement of the medium at a given point and c the concentration. The expression for $\vec{j}$ is

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$$\bar{j} = - D(t) \nabla c + \bar{v}c .$$

The continuity equation and the fact that the medium is incompressible lead to the following equation for the one-dimensional case

$$\frac{\partial c}{\partial t} = D(t) \frac{\partial^2 c}{\partial x^2} - v_x \frac{\partial c}{\partial x} \quad (1) .$$

In the case of a homogeneous medium

$$v_x = \frac{\dot{l}}{l} x \quad (2)$$

where l is the thickness of the specimen, which is a function of time, and

x is the distance from the surface of the specimen or some other fixed plane.

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Combining Eqs. (1) and (2) one obtains

$$\frac{\partial c}{\partial t} = D(t)\frac{\partial^2 c}{\partial x^2} + \frac{\dot{l}}{l}x\frac{\partial c}{\partial x} \qquad (3) .$$

The boundary conditions employed with Eq. (3) are

$$\frac{\partial c}{\partial x} = 0 \text{ при (when) } x = 0; \quad \frac{\partial c}{\partial x} = 0 \text{ при (when) } x = l(t) \qquad (3') .$$

Using the substitution

$$[illegible] = \frac{l_0}{l(t)}x; \quad \tau = \int_0^t \frac{l_0^2}{l^2(t')}D(t')\,dt' . \qquad (4)$$

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where l_0 is the thickness of the specimen at the initial instant of time, Eqs. (3) and (3') can be transformed to read

$$\frac{\partial c}{\partial \tau} = \frac{\partial^2 c}{\partial \xi^2}; \qquad (5)$$

$$\frac{\partial c}{\partial \xi} = 0 \text{ при } \xi = 0; \quad \frac{\partial c}{\partial \xi} = 0 \text{ при } \xi = l_0. \qquad (5')$$

When $l_0 = \infty$, the solution of this equation can be shown to be (Myunts - Ref. 4)

$$c(\xi, \tau) = \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} c_0(\xi - 2\alpha\sqrt{\tau})\, e^{-\alpha^2}\, d\alpha, \qquad (6)$$

where $c_0(x) = c_0(\xi)$ is the concentration at the initial instant of time. In the case where a thin layer of the diffusing

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substance is deposited on the surface of the specimen $c_o(x) = A\delta(x)$ and $\delta(x)$ is the delta function, Eq. (6) leads to the following expression

$$c = \frac{A}{\sqrt{\pi\tau}} e^{-\frac{x^2}{4\tau}} = \frac{A}{\sqrt{\pi \int_0^t D(t') e^{-2\varepsilon(t')} dt'}} \exp\left[- \frac{x^2}{4e^{2\varepsilon(t)} \int_0^t D(t') e^{-2\varepsilon(t')} dt'} \right], \qquad (7)$$

where

$$\varepsilon = \ln \frac{\ }{\ _0} .$$

As has been pointed out above, Eq. (7) was obtained by Simmons (Ref. 5) by a very much more complicated method. With an initial step change in the concentration, as is the case with thick layers ($c_o = c_1$ when $-\infty < x < 0$, $c_o = c_2$ when $0 < x < \infty$), Eq. (6) yields

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$$c(x, t) = \frac{c_1 + c_2}{2} + \frac{c_2 - c_1}{2} erf\left(\frac{x}{2\sqrt{Dt}}\right)$$

$$= \frac{c_1 + c_2}{2} + \frac{c_2 - c_1}{2} erf\left(\frac{x}{2e^{\varepsilon(t)}\sqrt{\int_0^t D(t')e^{2\varepsilon(t')}dt'}}\right) \quad (8).$$

$$erf(x) = \frac{2}{\sqrt{\pi}}\int_0^x e^{-\xi^2}d\xi$$

The solution given by Eq. (8) is not normalisable with respect to x , i.e.

$$\int_0^{\infty} c(x, t)dz \neq const.$$

for all instants of time, as should be the case when the thickness of an incompressible material is altered. On the

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other hand the volume integral of the concentration evaluated for a rectangular parallelipiped with unit cross-section at t = 0 and constant volume should be equal to a constant, i.e.

$$\int_0^{\infty}\iint_S c\,dx\,dy\,dz = S(t)\int_0^{\infty} c\,(x,\ t)dx = A$$

and since $S = \ell_o/\ell = e^{-\varepsilon}$, the normalisation condition becomes

$$\int_0^{\infty} c(x,\ t)\ dx = \frac{A}{S(t)} = Ae^{\varepsilon(t)} \qquad (9)$$

The expressions for the concentration given by Dovnar and Romashkin (Refs. 1, 2) are in error because they do not

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satisfy the normalising condition (Eq. 9) given here
(Abstractor's note this is an abridged translation)
There are 4 references: 3 Soviet and 1 non-Soviet

ASSOCIATION Institut metallovedeniya i fiziki metallov TsNIIChM (Institute of Metallurgy and Physics of Metals TsNIIChM)

SUBMITTED March 28 1960

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AUTHORS: Lyubov, B. Ya., Roytburd, A. L. S/020/60/131/02/024/071 B013/B011

TITLE: Energy Relations in Martensite Transformation

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol 131, Nr 2, pp 303-305 (USSR)

ABSTRACT: The authors derive the energy relations mentioned in the title under the following simplified premises: The pure shear k along the habit plane (gabitusnaya ploskost') zx is selected as the deformation with an invariant plane. The presence of a net of dislocations on the interface allows to neglect the deformations within the martensite crystal. The forces acting upon the martensite crystal from the deformed matrix, compensate with the forces of the surface tension on the interface between the phases. These premises are bound to influence the numerical results of computation to a certain degree. This can, however, be taken into the bargain, because the investigation under review aims at determining only certain general rules. Therefore, the anisotropy of the elastic properties of the material is also neglected with a view to simplifying calculations. The stressed state and the energy of the deformations occurring with the formation of an isolated martensite crystal, can be solved by solving the plane problem of the theory of elasticity. This solution holds for the region situated outside the elliptic hole (at the edge of which the dislocations $u = ky + \alpha x$; $v = \alpha y$ are given). Here, x and y denote

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the coordinates of the point at the edge of the opening, u and v the components of the shift toward the x- and y-axis respectively, k the shear, and α the dilatation parameter. By using function-theoretical methods one finds the following relation for the specific energy of elastic deformations: $E_0 = \mu(1+\frac{1}{\varkappa})\frac{k^2+\alpha^2}{2}\frac{b}{a} + \mu(1+\frac{1}{\varkappa})\frac{\alpha^2}{2}\frac{a}{b} + \mu(1-\frac{1}{\varkappa})\alpha^2$. Here, μ denotes the shear modulus, a and b the semimajor and semiminor axis of the ellipse (which constitutes the cross section of the martensite crystal) and $\varkappa = 3 - 4\nu$ holds. ν denotes Poisson's ratio. The free energy of the system changes with the formation of a martensite crystal which is coherent with the matrix, by $\Delta F = -(\Delta F_0 \pi - C)ab + Aa^2 + Bb^2 + \sigma s$. Here, ΔF_0 denotes the change in the "chemical" energy in the transition of a unit volume of the old phase into the new modification, and σ denotes the surface tension. The authors then determine a relation for the energetically optimum dimensions of the martensite crystal. With increasing growth of the crystal the ratio b/a decreases and tends toward a certain limit. If dilatation does not change (α=0), the relation b^2/a = const holds for the growth of the crystal, i.e.,

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the curvature of the elliptic surface of the crystal and of its growing edge remains constant. From the standpoint of thermodynamics the growth of the crystal is of interest only under a certain condition which is given here. There are 3 figures and 7 references, 1 of which is Soviet.

ASSOCIATION: Institut metallovedeniya i fiziki metallov Tsentral'nogo nauchno-issledovatel'skogo instituta chernoy metallurgii (Institute of Metallurgy and Metal Physics of the Central Scientific Research Institute of Ferrous Metallurgy)

PRESENTED: October 19, 1959, by G.V. Kurdyumov, Academician

SUBMITTED: October 15, 1959

AUTHORS: Lyubov, B. Ya., Roytburd, A. L.

S/020/60/131/04/025/073
B013/B007

TITLE: Temperature Conditions on the Surface of a Growing Martensite Crystal

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol 131, Nr 4, pp 809-812 (USSR)

TEXT: The authors of the present paper made the attempt of estimating the temperature conditions at various sites of the crystal surface in consideration of its shape. The solution of the problem of thermodynamic growth of the martensite crystal furnishes the true value of the moving force of this process. Mention is made of various earlier papers which are based only on qualitative considerations, whereas the solution of the afore-mentioned problem requires a quantitative investigation of the relations between heat emission and heat conduction from the growing surface. The shape of the crystal, which is usually not taken into account, is of great importance to such investigations. The martensite crystal may be described as an elliptic cylinder with a small ratio b/a of the semiaxes of the cross section. From the minimum condition holding for the energy of distortions of the crystal it follows for the radius of curvature of the crystal edge that $\varrho = b^2/a = (A/B)a + 2\sigma/B$. In this case it

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holds that $A = \mu(1 + (1/\varkappa))\pi\alpha^2/2$; $B = \mu(1 + (1/\varkappa))\pi(k^2 + \alpha^2)/2$; $\varkappa = 3 - 4\nu$; α and k denote the coefficient of linear expansion and the shear modulus of macroscopic deformation in the conversion of martensite, μ and ν - the torsion modulus and Poisson's ratio of the austenite die, σ - surface tension at the interface between austenite and martensite. As soon as the crystal dimensions exceed a certain critical size, the rate of growth in the longitudinal direction is determined by the rate of shift of those dislocations which form the interface between the crystal and the surrounding die. In this direction the crystal grows with the constant rate v, so that $\varrho = \frac{A}{B} vt + \frac{2\sigma}{B}$ holds. The determination of temperature on the edges of the crystal can be reduced to the determination of temperature on the vertex of a parabola moving along the x-axis with constant velocity. $\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = \frac{1}{\chi}\frac{\partial T}{\partial t}$ holds for the temperature field round the crystal, where χ denotes thermal diffusivity. The solution of this equation obtained for the corresponding conditions is written down. This solution can be used also in the case of a time-variable temperature field. ϱ is approximate-

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ly constant and equal to $2\sigma/B$ in the first stage of the process with $t \ll 2\sigma/Av$. With $q/c \approx 100^\circ$ it holds that $T_{surface} \approx 13^\circ$, i.e., the temperature of the crystal edge differs but little from the temperature of the surrounding medium. The thickness, b, of the crystal is related to the rate of its growth along the x-axis by the equation $b = \sqrt{\frac{A}{B} v^2 t^2 + \frac{2\sigma}{B} vt} = \sqrt{\varrho vt}$. In the initial period of growth the temperature prevailing on the plane crystal faces also differs but little from the temperature of the surrounding medium. $t \gg 2\sigma/Av$ holds for the further growth of the crystal. With $\beta\sqrt{t} \approx 3$ the process is adiabatic. The time necessary for attaining the steady state (which, in the case of a plane face, corresponds to the occurrence of adiabatic conditions) is inversely proportional to the rate of growth. In the initial stages, the growth of the crystal is an isothermal process, but when the martensite plate is formed, the conditions prevailing on its surface become more and more adiabatic. These adiabatic conditions are attained more rapidly on the blunted edge of the crystal than on its plane faces. There are 3 figures and 8 references, 3 of which are Soviet.

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Temperature Conditions on the Surface of a Growing Martensite Crystal

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ASSOCIATION: Institut metallovedeniya i fiziki metallov Tsentral'nogo nauchno-issledovatel'skogo instituta chernoy metallurgii (Institute of Metallography and Metal Physics of the Central Scientific Research Institute of Ferrous Metallurgy)

PRESENTED: November 30, 1959, by G. V. Kurdyumov, Academician

SUBMITTED: November 18, 1959

Card 4/4

IVANTSOV, G.P.; LYUBOV, B.Ya.; POLYAK, B.T.; ROYTBURD, A.L.

Calculation of the crystallization of a metallic ingot with various types of heat flow through its surface. Inzh.-fiz. zhur. no.3:41-47 Mr '60. (MIRA 13:10)

1. Institut chernoy metallurgii, Moskva.
(Crystallization)

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S/058/62/000/005/070/119
A061/A101

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AUTHORS: Lyubov, B. Ya., Temkin, D. Ye.

TITLE: Distribution of soluble impurities in crystallization

PERIODICAL: Referativnyy zhurnal, Fizika, no. 5, 1962, 10, abstract 5E84 (V sb. "Rost kristallov. T. 3", Moscow, AN SSSR, 1961, 59 - 67. Discuss., 214 - 218)

TEXT: The distribution of a soluble impurity in solid phase on crystallization from a melt has been determined. The following assumptions are made in solving the problem: 1) the problem is one-dimensional (plane front of crystallization moving according to a certain law y(t)); 2) the impurity is unlimitedly soluble both in the melt and in the solid phase; 3) the law y(t) is postulated; 4) near the liquid-solid interface, equilibrium is established almost instantaneously; 5) convection is absent, and mass transfer takes place only by molecular diffusion. A general method of solving the problem is presented, together with the boundary conditions and the fundamental integral equation representing the solution. An approximate solution of this equation is given for two courses

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Distribution of soluble impurities in crystallization

of y(t), i.e., crystallization taking place at a constant rate, and crystallization by the law $y(t) \sim \sqrt{D_2 t}$, where D_2 is the coefficient of impurity diffusion in the melt. The two solutions are of a like nature, since the impurity concentration grows from initially solidified portions to those solidifying later. The conditions, under which the impurity distribution is bound to be sharply non-uniform, are analyzed.

K. Gurov

[Abstracter's note: Complete translation]

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