S/129/60/000/06/005/022
E073/E535

Influence of Polymorphous Transformations on Diffusion in Titanium

high strength of the interatomic bonds. The following conclusions are arrived at:

1) The coefficient of diffusion in α-titanium at the transformation temperature is larger by about two orders of magnitude and even more and the activation energy of the process is half that of β-titanium. A qualitatively equal relation is observed in commercially pure titanium but the diffusion mobility in this is considerably lower and the activation energy is higher than in iodide titanium.

2) The difference in the diffusion parameters of α and β-titanium may be due to differing strength of the interatomic bonds or may be associated with structural features of α-titanium.

3) Structural changes in titanium in the process of diffusion annealing lead to an acceleration of the process of diffusion.

There are 3 figures, 2 tables and 17 references, 7 of which are Soviet and 10 English.

Card 4/4

17.4310 2308

S/129/60/000/009/001/009
E193/E483

AUTHORS: Kishkin, S.T., Member-Correspondent AS USSR and Polyak, E.V., Candidate of Technical Sciences

TITLE: Kinetics of Rupture of Heat-Resistant Alloys in Creep

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov, 1960, No.9, pp.2-6 + 2 plates

TEXT: To elucidate the mechanism of rupture of Ni- and Cr-base alloys under prolonged load at high temperatures, creep tests were conducted in vacuum (10^{-5} mm Hg) on flat test pieces with one of the sides carefully polished so that the changes in the microstructure could be periodically observed with the aid of a low power (x 200) microscope, without interrupting the tests. To supplement these studies, an electron microscope was used to examine the fine microstructure of the test pieces on the completion of the tests. The following conclusions were reached: 1) During the first 30 to 50% of the life of specimens, tested in creep, microcracks are formed at the grain boundaries which are normal to the direction of the applied stress. With increasing duration of creep, the number and the size of microcracks increase, leading ultimately to fracture of the specimen.

Kinetics of Rupture of Heat-Resistant Alloys in Creep

2) The alloys studied in the course of the present investigation (ZhS3, EI617) exhibited relatively high elongation (10 to 15%) when subjected to short-time high-temperature tests but failed by brittle fracture when tested in creep at the same temperature, the elongation under these conditions being only 1 to 3%. This difference is attributed to the fact that in the former case, fracture is preceded by plastic deformation within the grains, whereas in the latter case, fracture is brought about mainly by the formation of cracks at the grain boundaries, little evidence of deformation within the grains having been observed.
3) In the case of the ZhS3 alloy, in the as-cast condition, the formation of cracks takes place later than in the material that has been subjected to preliminary mechanical treatment. This effect is attributed to the fact that the growth of cracks in the cast alloy is arrested by the carbide precipitates.
4) The formation of microcracks can be delayed and the life of the specimen increased if a thin surface layer is removed from the surface of the specimen by electrolytic polishing. There are 8 figures and 9 references: 8 Soviet and 1 English.

Card 2/2

KISHKIN, S.T., doktor tekhn.nauk; KLYPIN, A.A., kand.tekhn.nauk;
NIKOLENKO, V.V., kand.tekhn.nauk

Characteristics of metal failure at high temperatures. Trudy
MAI no.123:5-16 '60. (MIRA 13:8)
(Heat-resistant alloys) (Thermal stresses)

KISHKIN, S.T., doktor tekhn.nauk; KLYPIN, A.A., kand.tekhn.nauk;
KARYAKINA, N.V., kand.tekhn.nauk, NIKOLENKO, V.V.; CHERNOV, M.N.

Investigating the relation of structure and properties of materials for gas-turbine blades to the duration of their use. Trudy MAI no.123:25-34 '60. (MIRA 13:8)
(Gas turbines--Blades)

BOKSHTEYN, S.Z., doktor tekhn.nauk; GUDKOVA, T.I., kand.tekhn.nauk; ZHUKHOVITSKIY, A.A., doktor khim.nauk, KISHKIN, S.T., doktor tekhn.nauk

Effect of prestressing and of the creep process on diffusion inside and along the grain boundaries. Trudy MAI no.123:35-40 '60. (MIRA 13:8)

(Crystal lattices) (Creep of metals)

KISHKIN, S.T., doktor tekhn.nauk; BENEDIKTOVA, G.P., inzh.

Strength of alloys in contact with sodium. Trudy MAI no.123:45-52 '60. (MIRA 13:8)
(Alloys--Testing) (Sodium) (Nuclear reactors--Materials)

KISHKIN, S.T., doktor tekhn.nauk; SEMICHASTNOVA, V.P., kand.tekhn.nauk;
GENKE, O.V., inzh

Failure of nickel-base alloys under the effect of repeated loading. Trudy MAI no.123:69-75 '60. (MIRA 13:8)
(Nickel alloys--Testing)

KISHKIN, S.T., doktor tekhn.nauk; PODZEY, A.V., kand.tekhn.nauk; KARYAKINA, N.V., kand.tekhn.nauk, NIKOLENKO, V.V., kand.tekhn. nauk, LOGINOV, V.Ye., inzh., GRIBOVSKI, L., inzh.

Investigating the quality of the surface layer on ramjet, gas-turbine blades. Trudy MAI no.123:76-89 '60. (MIRA 13:8)
(Airplanes--Ramjet engines)
(Gas turbines--Blades)
(Surface hardening)

85379

S/032/60/026/010/007/035
B016/B054

18.7500 2308, 1555, 1146

AUTHORS: Bokshteyn, S. Z., Gubareva, M. A., Kishkin, S. T., and Moroz, L. M.

TITLE: Study of the Process of Iron Recrystallization by the Method of Radioactive Isotopes

PERIODICAL: Zavodskaya laboratoriya, 1960, Vol. 26, No. 10, pp. 1111-1114

TEXT: The authors studied the behavior of atoms at the grain boundaries during the recrystallization of iron (content in %: 0.021 C, 0.014 P, 0.011 S, 0.67 Si, 0.07 Al, 0.08 Mn, 0.06 Ni, 0.033 Cu). Samples of this iron were covered with Fe^{59}. In annealing, Fe^{59} spread due to diffusion at the boundaries between the metal grains. This permitted an observation of the local displacement of atoms lying at the boundary during deformation and recrystallization annealing. Iron rods were annealed at 1250°C for 8 h, and then cut into samples (10 x 10 x 20 mm). The riveted layer (70-80μ) was removed by electropolishing in perchloric and glacial acetic acids. An Fe^{59} layer 1.0 μ thick was electrolytically applied to

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Study of the Process of Iron Recrystallization by the Method of Radioactive Isotopes

the polished surface. Subsequently, the samples were deformed by compression by 10-16% (Fig. 4) and by 45-70% (Fig. 2). Figs. 1-8 show the autoradiogram (a) on the left, and the microstructure (b) on the right on microphotographs. During exposure the samples were protected by a film 1 μ thick (1% of Zapon varnish in the solvent РДВ (RDV)). To produce the autoradiograms, the samples were exposed for several days on photographic plates or films НИКФИ (NIKFI), type МР(MR). The autoradiograms were compared with the microstructure pictures which had been taken by a microscope of the type МИМ-8 (MIM-8). Next, the recrystallization annealing was carried out (Figs. 3, 5-8). A Table on p. 1113 gives the hardness and the methods of treatment for some samples. On the basis of their methods, the authors succeeded in observing the behavior of grain boundaries during plastic deformation and subsequent recrystallization. It was proved that iron recrystallization at relatively low (15%) and high (50-70%) degrees of deformation causes no essential change in the position of atoms laying at the boundary of deformed grains. With a considerable structural change of the metal after a double recrystallization, as well as

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Study of the Process of Iron Recrystallization by the Method of Radioactive Isotopes

S/032/60/026/010/007/035
B016/B054

after polymorphous $\alpha \rightarrow \gamma$ transformation, the atoms at the boundaries of the initial bodies are not displaced. In contrast with recrystallization, plastic deformation is accompanied by a considerable displacement of atoms. The results prove that the displacement of grain boundaries during recrystallization and the subsequent growth of grains is connected with a specific mechanism which differs from the ordinary diffusion mechanism. There are 8 figures, 1 table, and 15 references: 4 Soviet, 1 US, 1 Dutch, 1 French, and 4 German.

Card 3/3

34547
S/659/61/007/000/036/044
D205/D303

18.1151
AUTHORS: Kishkin, S.T., and Polyak, E.V.

TITLE: Kinetics of the break of heat resisting alloys in the creeping process

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Issledovaniya po zharoprochnym splavam, v. 7, 1961, 295 - 308

TEXT: The heat resisting alloys used at high temperatures and stresses are disrupted mainly along the grain boundaries at very low plastic deformations and the whole process is considered to be slow. Microcracks are first formed which then develop until a break occurs. This work is concerned with the kinetics of the break of industrial, heat resisting Ni-Cr alloys taking into account external factors (temperature, time, stress) and internal factors (structure, state of grain boundaries and of the surface layer). The vacuum metallography method of investigation was applied which permits direct observation at high temperatures and stresses. Microphotographs taken at various time intervals describe the kinetics of break between

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Kinetics of the break of heat ...

700 - 900°C for stresses of up to 60 kg/mm^2. Development of the breaking process is discussed. After 30 - 50 % of the life time of the sample microcracks appear on the grain boundaries, directed normally to the tension stresses. In time the number and dimensions of the cracks grow, causing the material to break. Increased stress accelerates the process which proceeds in two stages: Gradual development of the cracks on the grain boundaries followed by a fast final break. No appreciable internal slip was observed in the grains of the Ni-Cr alloys at high temperatures and at usual working stresses. The break occurs by the development of the cracks at 1 - 3 % elongation, while at very high stresses (of the yield point order) the elongation reaches 10 - 15 % which is caused by very intensive internal slip. The surface damage on prolonged heating, connected with the oxidation and burning out of some of the alloying elements, accelerates the development of the cracks, lowering the durability of the material. Surface protection is, therefore, required to ensure longer working life. The coarse structural non-uniformity showing itself on the surface in liquation strips and oxide films causes premature crack developments and break. Removal of the dama-

Card 2/3

18.9200

27832
S/032/61/027/010/002/022
B110/B101

AUTHORS: Blok, N. I., Mishkin, S. T., Kozlova, M. N., and Lashko, N. F.

TITLE: Phase analysis of surface layers of heat-resistant nickel alloys

PERIODICAL: Zavodskaya laboratoriya, v. 27, no. 10, 1961, 1165-1169

TEXT: The methods based on a total determination of the chemical composition of the test layer used so far for investigating surface layers of alloys heated in air are insufficient for studying the processes taking place. For this purpose, the authors elaborated a method of phase analysis in layers, and were able to determine the distribution of alloying elements among the individual phases, their nature and content in each layer. 8 - 10 anode deposits taken by layers and the corresponding portions of electrolyte were analysed chemically. From another sample anode deposits are separated in layers for X-ray structural analysis. By micrometer and calculation by weight of the metal dissolved, the layer depth was determined as being ~0.005 to 0.05-0.06 mm. Uniform dissolution on the entire sample surface is necessary. A crystalliser holding ~350 ml

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27032
S/032/61/027/010/002/022
B110/B101

Phase analysis of surface layers of ...

served as electrolyte vessel. The 45-50 mm long cylindrical sample (diameter 10-12 mm) served as anode. The cylindrical cathode from stainless steel reached like the anode to the bottom of the vessel. The level of the electrolyte was not higher than the anode height. The following materials were investigated: Alloys of the type ЭИ437 (EI437) after 8 hr heating at 1080°C, 16 hr aging at 700°C, and cooling in air; and of the type ЭИ617 (EI617) after 2 hr heating at 1190°C, 4 hr heating at 1050°C, 16 hr aging at 800°C, and cooling in air. Oxidation of surface layers (A) occurs frontally. In deeper layers (B), oxygen diffusion takes place along grain boundaries. Dissolution on the surface is sufficient for A; dissolution must penetrate deeper for B in order to obtain satisfactory results of analysis. The dissolution was performed with electrolytes 1S (10 g $(NH_4)_2SO_4$ and 10 g citric acid in 1200 ml H_2O) and S1 (5% solution of hydrochloric acid in CH_3OH). In 1S, the γ'-phase, oxides and carbides, in S1 oxides and carbides are separated. Phase separation in layer I takes place by means of 0.05 a/cm^2 and 1S. Layer II (oxides and solid solution

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Phase analysis of surface layers of ...

poor in alloying elements) is not dissolved at EI617, and only selectively at EI437. When operating with 18, the boundary between layers II and III may be determined owing to the appearance of the α'-phase in the anode deposit. Layer II of EI617 is dissolved in 81 under continuous control of the solubility in 18. For this purpose, the analytically weighed sample is immersed in 18 and, unless it dissolves here, it is dissolved for ~10 min in 81, the deposit is removed, dried, weighed, and the cycle is repeated up to dissolution and separation of the α'-phase in 18. Layer III consisting of solid solution (poor in alloying elements) and α'-phase on the basis of $Ni_3(Al,Ti)$, as well as layer IV of initial alloying composition, are dissolved in 18. The anode deposit separated in 18 and 81 (layer II, EI617) is filtered off and washed out with 0.2% electrolyte solution up to negative Ni^{2+} reaction. Electrolyte and rinsing water are united, evaporated, filled up to 200-250 ml; 50 ml of it is mixed with 10 ml H_2SO_4 (1.84) and heated. H_2O_2 is added to the dark-brown liquid obtained. It is heated up to destruction of H_2O_2, filled up to 100 ml, and the elements are determined. Anode deposit I is molten with $KHSO_4$, the

Phase analysis of surface layers of...

melt is dissolved in 5% H_2SO_4, and filled up to 200-250 ml. According to X-ray structural and chemical analyses, layer I (up to 0.005 mm depth) is strongly enriched with Cr, Al, and Ti. It consists of Me_2O_3 (Cr_2O_3, Al_2O_3, $NiO \cdot TiO_2$) with trigonal crystal structure, the parameters of which are similar to those of Cr_2O_3. In layer II (in ~0.027 mm depth of EI 437 and in ~0.40 mm depth of EI617), as in layer I, α'- and carbide phases are destroyed through Cr-, Al-, Ti and C diffusion to the periphery, and the oxides are formed. Layer III is ~0.10 mm depth in EI437 and ~0.15 mm in EI617. In EI437, the Me_2O_3 are enriched with Cr in peripheral layers, and with Al in deeper ones. In EI617, Al_2O_3 already exists at small depth, which suggests a missing equilibrium state. Gas turbine blades of ЭИ437А (EI437A) operating at $\leqslant$700°C, where uniform dissolution was difficult, were tested in this way. Layer I was missing (mechanical wear). Impoverishment in chronium was found down to 0.075 mm. The Ti content of the surface layer was constant. The Al enrichment at a certain depth cannot be explained. Destruction processes on the surface starting at the grain

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Phase analysis of surface layers of ...

boundaries are explained by deep oxygen diffusion along the grain boundaries. N. M. Rudneva, N. A. Shumilina, K. V. Smirnova, and A. N. Sokolov assisted in the experiments. There are 3 figures, 2 tables, and 4 references: 3 Soviet and 1 non-Soviet.

Card 5/5

33464
S/129/62/000/001/007/011
E073/E335

18.1151 1426 1496

AUTHORS: Kishkin, S.T., Corresponding Member of the AS USSR,
Lozinskiy, M.G., Doctor of Technical Sciences,
Bokshteyn, S.Z., Doctor of Technical Sciences, Professor,
Sokolkov, Ye.N., Candidate of Technical Sciences

TITLE: Influence of high-temperature plastic deformation on the mechanical properties of heat-resistant nickel-base alloys

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov, no.1, 1962, 38-40 + 1 plate

TEXT: Two Ni-Cr-base alloys were investigated: the low-carbon ЭИ437Б (EI437B) alloy of the standard composition and the ЭИ617 (EI617) alloy, containing 0.12% C and additions of W and Mo. The alloy EI437B was subjected to the following thermo-mechanical treatment: blanks of 16 mm diameter were first soaked for 8 hours at 1080°C and rolled at this temperature at a rolling speed of 4.5 m/min to 30% reduction. 0.2 to 0.3 sec after deformation, the blanks were quenched to supercool the austenite

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Influence of ...

and to retain the structure, produced as a result of high-temperature plastic deformation. The blanks were then aged at 700°C for 16 hours. Blanks of the alloy EI617 were heated to 1200°C and stamped in a press, so that an average reduction of 30% was achieved; this was followed by quenching in water. The blanks were then aged at 800°C for 16 hours. The results of static tensile and impact tests at room temperature are given in Table 1. Studies of the influence of thermomechanical treatment on the creep strength of austenitic steels revealed that recrystallization should be prevented during high-temperature plastic deformation since it would cancel out the beneficial effects of the thermomechanical treatment. Microstructural investigations correlated with the results of mechanical tests indicate that the increase in strength and ductility occurs even if recrystallization has not been fully suppressed. The increase in strength is attributed to an increase in the quantity of the carbide phase, to changes in the finely crystalline

Influence of ....

structure of the material and to texturing. The large increase in the ductility of the investigated alloys is obviously due to the absence of intercrystalline fracture. The following participated in the experiments: N.I. Korneyev; T.A.Gordeyeva, Ye.I. Razuvayev, O.N. Podvoyskaya, M.N. Kozlova, L.M. Strizhevskaya, T.A. Volodina, N.F. Lashko, E.V. Polyak, G.N. Korableva, A.V. Bulanov, M.I. Spektor and I.G. Skugarev. There are 2 tables and 7 references: 4 Soviet-bloc references and 3 non-Soviet-bloc. The three English-language references mentioned are: Ref. 4: E.B. Kula, J.M. Ohosi - "TASM", v.52, 1960; Ref. 5: D.J.Schmatz, J.C. Shyne, V.F. Zackay - Metal Progress, v.76, no. 3, 1959; Ref. 7: E.B. Kula, S.L. Lopata - Trans. AIME, v.215, 1959.

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33464
S/129/62/000/001/007/011
E073/E335

Influence of ....

Table 1:

Alloy	Treatment	Mechanical Properties					
		$\sigma_{0.2}$, kg/mm^2	σ_b, kg/mm^2	δ, %	ψ, %	a_k, kgm/cm^2	HB (d_{oan}, mm)
EI437B	Standard (reference specimens)	-	97.0	25.0	20,9	-	-
	TMO *	-	119	32.0	30.7	-	-
EI617	Standard (reference specimens)	71.7	103.7	14.6	10.1	1.8	3.6
	TMO*	93.8	129.6	31.2	25.9	7.8	3.35

* Plastic deformation of supercooled austenite followed by conventional hardening and tempering treatment.

Card 4/4

37728

S/180/62/000/002/001/018
E193/E383

1.1700

AUTHORS: Bokshteyn, S.Z., Kishkin, S.T., Lozinskiy, M.G. and Sokolkov, Ye.N. (Moscow)

TITLE: Thermomechanical treatment of a chromium-nickel-manganese austenitic steel

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Otdeleniye tekhnicheskikh nauk. Metallurgiya i toplivo, no. 2, 1962, 15 - 21

TEXT: The, so-called, "thermomechanical treatment" (TMO) consists essentially of combining plastic deformation at temperatures above the recrystallization temperature with quenching under conditions precluding recrystallization of the plastically deformed material. The effect of this treatment on the structure and properties of various materials has already been studied by other workers. Some additional data on TMO of austenitic steels are presented in the present paper, with particular reference to the properties of these steels after TMO to the ageing treatment and to some characteristics of the diffusion processes. The experiments were conducted on chromium-

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Thermomechanical treatment....

nickel-manganese austenitic steel ЭИ 481 (EI481) specimens, 13 and 60 mm in diameter, the former 150 and the latter 250 mm long. The plastic-deformation part of TMO was effected by rolling at 2.4 m/min in the case of specimens 60 mm in diameter and at 4.5, 7.5 and 13.5 m/min in the case of 13 mm diameter specimens. 25 and 30% reduction was given in each case. Recrystallization of the 13 mm diameter specimens was suppressed by immediate quenching in a water tank mounted on the rolls housing, the time interval between completion of the rolling operation and quenching amounting to 0.2 to 0.3 sec. Rapid cooling of the 60 mm diameter specimens was attained with the aid of a specially designed spraying device. Preheating of the test pieces for rolling was done in air in an electric furnace, the preheating temperature and time being 1 180 °C and 2 hours, respectively. TMO of small (13 mm diameter) test pieces was carried out after cooling them from 1 180 to 1 100 °C. In the case of large (60 mm diameter) test pieces TMO was applied at the preheating temperature and after cooling

Thermomechanical treatment ....

to 1 150, 1 100, 1 050 and 1 000 °C. A number of test pieces were given conventional treatment (water-quenching) to obtain control specimens for comparison. All the test pieces (whether quench-hardened or subjected to TMO) were aged at 680 °C for 10 hours, after which they were given an additional treatment of 10 hours at 790 °C, followed by air-cooling so as to attain hardness corresponding to the indentation diameter $d_{отп}$ =

= 3.5 - 3.7 mm. In addition to standard tensile tests at room temperature, tests at 650 °C were carried out under conditions of short and prolonged loading, the latter (i.e. creep) tests being conducted under an applied stress of 39 or 43 kg/mm^2.
To study and compare the progress of diffusion processes in material subjected to TMO or given the conventional treatment, the rate of diffusion was measured by a radioactive-tracer technique, entailing cutting a taper section across the diffusion region.
A thin film of Fe^{59} was electrodeposited on the specimens studied, which were then given a 150-hours diffusion-annealing treatment at 800 °C in vacuum, after which both volume and grain-boundary

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Thermomechanical treatment ....

diffusion coefficients were determined. Overall diffusion coefficients were also calculated with the aid of the absorption method. Phase-analysis was used to study the effect of hot plastic deformation on the process of carbide-formation during ageing. Electrolytic extraction of the carbide phase from various test pieces was carried out in a 5% solution of hydrochloric acid in methanol. The anode residues were also examined by X-ray diffraction measurements. Preliminary examination of the microstructure revealed that, irrespective of the rolling speed employed during TMO, full suppression of recrystallization had been achieved in small (13 mm diameter) test pieces only. None of the TMO procedures used on large (60 mm diameter) test pieces had ensured suppression of the recrystallization process. The results of standard tensile tests at 20 and 650 °C, carried out on small specimens, showed that TMO brought about a slight increase in UTS at 20 °C (from 108 - 114 kg/mm^2) but had no effect on the strength of steel at 650 °C. The variation in plasticity was somewhat different.

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Thermomechanical treatment ....

Thus, as the rolling speed during TMO increased, the elongation of steel at room temperature decreased below that of specimens heat-treated in the conventional manner and then increased to exceed this value. The same applied to reduction in area which, after TMO entailing deformation by rolling at 13.5 m/min, attained a value of 33.2%, i.e. 25% higher than the value attained after conventional treatment. The results of tensile tests at 650 °C also showed a slight increase in elongation of specimens subjected to TMO, although reduction in area of specimens rolled at 13.5 m/min was somewhat lower than that of the control test pieces. The results of accelerated creep tests conducted on small test pieces under a stress of 43 kg/mm^2 showed that irrespective of the conditions during TMO, the time-to-rupture of the steels studied increased after this treatment by 20-25%. The corresponding increase for specimens tested under a stress of 39 kg/mm^2 amounted to 600%. Metallographic examination of small specimens showed that recrystallization during TMO had been completely suppressed in each of the specimens examined. This was indicated by the absence of new small crystals which

Thermomechanical treatment ....

were usually formed in recrystallized material along the boundaries of the original grains. A common specific structural feature of all specimens subjected to TMO was distortion of grain boundaries which had assumed a characteristic serrated contour. A distinguishing feature of specimens rolled during TMO at a speed of 4.5 m/min was well-developed sub-structure. The formation of sub-structure was associated with the formation of blocks (several tens of microns in size) in the interior of the grains. The relatively large angular misalignment of these blocks was indicated by the ease with which the block boundaries could be revealed by etching. No such clearly defined sub-structure was observed in specimens rolled during TMO at higher speeds, although in a few isolated instances there was some evidence of block formation. The formation of the fine structure could be attributed to polygonization processes and subsequent decoration of the low-angle boundaries by the solute atoms and second-phase particles. Another specific feature of the structure produced by TMO is the fragmentation of grains, i.e. sub-division

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Thermomechanical treatment ....

of grains into parts whose dimension are commeasurable with the size of the grains themselves. It would appear that fragmentation is mainly a result of intensive twinning taking place during hot plastic deformation. As stated already, none of the TMO procedures applied to large (60 mm diameter) test pieces ensured complete suppression of recrystallization, the extent of which increased with depth so that an unrecrystallized structure was observed only in the very surface layers of the material. In this case TMO had practically no effect on the resistance-to-creep of the steels studied. The results of phase analysis showed that although the chromium-carbide content of specimens subjected to TMO had increased considerably, it was independent of the rolling speed employed in the course of this treatment. The vanadium-carbide content of the material was practically unaffected by TMO. Finally, the results of diffusion studies indicated that after TMO the coefficient of volume diffusion of iron in steel at 800 °C increased fourfold. Since, owing to a general increase in the diffusion mobility, difficulties were encountered in determining the grain-boundary diffusion

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coefficient, the overall diffusion coefficients were measured by the absorption method. Comparison of the results obtained for test pieces with different structures showed that the overall diffusion coefficient for materials which had undergone TMO was more than twice as high as that for specimens given the conventional treatment. The general conclusion reached was that in addition to the previously established strengthening effect of grain-boundary distortion caused by TMO, the beneficial effect of this treatment on the high-temperature properties of steel was associated with an increase in the quantity of the strengthening phase and, possibly, with refinement of the mosaic structure and formation of slight texture. There are 4 figures and 2 tables.

SUBMITTED: October 11, 1961

34841
S/129/62/000/003/002/009
E111/E335

18.7500

AUTHORS: Bokshteyn, S.Z., Doctor of Technical Sciences, Professor, Kishkin, S.T., Corresponding Member of the Academy of Sciences and Moroz, L.M., Candidate of Technical Sciences

TITLE: Influence of carbon on the movement of grain boundaries in the recrystallization of iron

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov, no. 3, 1962, 8 - 13

TEXT: Lücke and Detert (Ref. 1 - Acta Metallurg, v.5, no. 11, 1957) and Beck (Ref. 2 - Metal Interfaces, Cleveland ASM, 1952) consider that there is a sharp drop in the speed of recrystallization when the concentration of an impurity reaches some critical value (about 0.01%) below the solubility. Impurities forming a second phase also retard the growth of recrystallization centres. Using their radioactive-isotopes technique (Ref. 6- "Zavodskaya laboratoriya, no. 10, 1960) the present authors and M.A. Gubareva have studied the influence of carbon on the behaviour of grain boundaries in the recrystallization of

Card 1/4

Influence of carbon on ....

technical-grade iron. Carbon was chosen as an element practically insoluble in alpha-iron; it is known to lead to an increase in the activation energy of recrystallization of iron and, if present in quantities even slighly in excess of its solubility, to prevent collective recrystallization, particularly at 620 - 700 °C. Specimens were saturated with carbon from donors at 700 °C for 2 hours. The behaviour of carbon atoms at iron-grain boundaries was followed directly during deformation and subsequent recrystallizing annealing. Recrystallization was studied on specimens 10 - 15 and 50 - 70% deformed, the first being in fact close to the critical value. Autoradiograms obtained before and after deformation were compared. From this and the microstructure the behaviour of the carbon was evaluated. The sizes of all grains increased after deformation; heating to 550 °C failed to produce recrystallization but growth of alpha-phase grains occurred. Carbon tended to move towards grain boundaries even when this meant going into a region of higher carbon concentration. At 650 °C recrystallization was almost complete, the carbon remaining at

the grain boundaries produced after heating at 550 °C. Although recrystallization was practically instantaneous, a completely new fine-grained structure was produced. Heating to 750 °C produced growth of recrystallized grains and movement, not always complete, of carbon to the new grain boundaries. Recrystallization annealing at 700 °C for 45 min of specimens after 13% deformation gave little change in microstructure; carbon moved from the boundaries of deformed grains to those of the new recrystallized grains. The influence of the alpha-gamma transformation on the behaviour of carbon atoms located at boundaries was studied in another series of experiments. For this purpose specimens were heated at 950 °C for 1 hour. Completely new grains were produced, the carbon both migrating to them and forming large accumulations of carbides. It is evident that the behaviour of impurity atoms located at boundaries and forming interstitial solutions is very different from that of boundary atoms of the base element; as shown previously (Ref. 6), boundary atoms in iron recrystallization

X

Influence of carbon on ....

(or polymorphic transformation) remain in practically the same position; carbon atoms follow newly-formed grain boundaries.
There are 8 figures and 1 table.

Card 4/4

S/806/62/000/

AUTHORS: Bronfin, M.B., Bokshteyn, S.Z., Kishkin, S.T.

TITLE: The self-diffusion of molybdenum in molybdenum-zirconium alloys.

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Issledovaniye splavov tsvetnykh metallov. no.3. 1962, 12-18.

TEXT: The paper describes experimental work done to clarify the dependence of the volumetric self-diffusion (SD) parameters of Mo on two factors: (1) the amount of alloying Zr present; (2) the antecedent cold-working of Mo alloys. The work is intended as a contribution to correlations between the rate of self-diffusion and creep, such as those which O.D. Sherby, R.L. Orr, et al. have tried to establish causally (J. of Metals, v.6, no.1, Sect.I, 1954, 71-79; Trans. ASM, v.46, 1954, 113-128). Test material and methodology: Large-grain specimens were used to reduce the share of boundary diffusion in the total diffusional flux. The Mo and its Zr alloys were vacuum arc-smelted, rolled into an 18-mm diam rod, and high-T annealed at above 1700°C; the alloys ranged from 0.005% Zr to 0.54% Zr. Right-cylindrical plane-parallel specimens 14-mm diam, 4-mm high, were cut out of the rods and were subjected to a 10-15-hr stabilizing anneal at 1,950-2,000°C in a 10^{-3}-10^{-4} torr vacuum, whereupon the grain size in all specimens attained 1-2 mm.

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S/806/62/000/003/002/018

The self-diffusion of molybdenum ...

Part of the specimens were upset on a press at 20° (height reduction 25%) to investigate the effect of cold working on the SD of the Mo. The specimens were electrically polished, whereupon one of their faces was activated with radioactive Mo^{99} in a galvanic bath. Diffusion anneal was then performed in a special vacuum furnace (exploded view shown) at 10^{-3}-10^{-4} torr and 1,720-2,000°C. The SD coefficient was measured by the two senior authors' method (Zavodskaya laboratoriya, no.7, 1960, 828-830) based on the shift in the activity curve (summarized). Test results: The self-diffusion parameters measured (and tabulated) indicate an appreciable augmentation effect of even small additions of Zr on both the self-diffusion activation energy of the Mo and the factor before the exponential term. Thus, at T above 2,000°C the SD coefficient of Mo does not depend on the alloying, but at T below 1,700°, in which the value of the activation energy is decisive, the SD rate decreases with increasing Zr content (numerical values tabulated). Even though antecedent cold-working depresses the SD activation energy of the Mo in Mo-Zr alloys, the activation energy of upset specimen increases with increasing Zr content. Inasmuch as the diffusion anneal of the deformed alloys was performed at a T substantially above their recrystallization T, the latter was completed in but a fraction of the anneal time, and the diffusion in the grain volume continued through an extended time in the absence of any structural transformation, so that any observed lowering of the SD activation energy of the Mo is regarded as a result of irreversible structural changes attribu-

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table to the cold-working of the alloy. The increase in activation energy during the anneal is attributed to a healing of crystalline-lattice defects which previously had served as "short-cut paths" for the diffusion; cold-working appears to firm up the defects, thereby inhibiting the healing effect of the anneal. The relationship between the SD coefficient and the activation energy is further examined and, in agreement with G. J. Dienes (J. Appl. Phys., v.21, no.11, 1950, 1189) and 3 Soviet authors, is found to be exponential. The results of this investigation agree with existing knowledge on the favorable effect of relatively small additions to Mo on its recrystallization T, its hardness (ref. Pipitz, E., Kieffer, R.. Zs. f. Metallkunde, v. 46, no. 3, 1955, 187-194), and its high-T stress-rupture strength (Northcott, L. Molybdenum. Russian translation, Moscow. Foreign Lit. Publ. House, 1959, 107-108). There are 2 figures, 4 tables, and 16 references (11 Russian-language Soviet, 1 German cited above, 4 English-language of which 1 is a Russian translation).

ASSOCIATION: None given.

Card 3/3

BOKSHTEYN, S.Z.; KISHKIN, S.T.; SVETLOV, I.L.

Breaking test for whiskers of copper, nickel, and cobalt crystals. Fiz.tver.tela 4 no.7:1735-1742 Jl '62.
(MIRA 16:6)
(Strength of materials--Testing) (Metal crystals)

S/129/62/000/009/001/006
E071/E492

AUTHORS: Bokshteyn, S.Z., Doctor of Technical Sciences, Professor, Bronfin, M.B., Engineer, Kishkin, S.T., Doctor of Technical Sciences, Professor, Moroz, L.M., Candidate of Technical Sciences

TITLE: Grain boundaries on recrystallization

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov, no.9, 1962, 6-8

TEXT: This is a continuation of earlier work ("Zavodskaya laboratoriya", no.10, 1960). The behaviour of W, Ni, Sn and C admixtures present at the grain boundaries during recrystallization of iron (0.021% C, 0.014% P, 0.011% S, 0.67% Si, 0.07% Al, 0.08% Mn, 0.06% Ni, 0.033% Cu) was studied by autoradiographic investigation and microstructural analysis. The admixtures, forming with iron substitutional solid solutions in the case of W, Ni, Sn and interstitial solid solutions in the case of C, were introduced by diffusion saturation at 600 to 700°C. The recrystallization was carried out after preliminary deformations of 10 to 15 and 50 to 70%. The Ni, W and Sn were completely

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Grain boundaries ...

soluble in iron at all recrystallization temperatures investigated and remained in their original lattice positions, despite substantial changes in the structure of the metal. The behaviour of carbon atoms was substantially different: above 750°C carbon passed from the boundaries of deformed grains to the boundaries of new recrystallized grains. However, in the initial stages of recrystallization (after 30 to 45 min at 650 to 750°C) carbon atoms remain at the boundaries of the initial grains and boundaries of the new grains remain free from carbon. The possibility of "heredity", i.e. preservation of the initial structural and concentration non-uniformities in recrystallized metal was demonstrated on a molybdenum alloy (0.54% Zr, 0.005% Cr, 0.0008% Ti and 0.011% C). A thin layer of tungsten 185 was electrodeposited on the surface of a flat specimen of the deformed alloy, submitted to a preliminary annealing at 1700°C. The activated specimen was then annealed in vacuo at 1750°C for 100 hours. Autoradiographs of an oblique section showed the presence of an accelerated diffusion not only along the boundaries of the newly formed grains but also a preferential penetration of

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the W^{185} along those sections where old grain boundaries were passing before recrystallization. The velocity of diffusion along the old boundaries was lower than along the new boundaries, nevertheless it was noticeably faster than volume diffusion. The results confirmed that within the grains the process of grain boundary migration does not produce as high concentration of defects as is produced at the beginning and at the end of the boundary migration. There are 6 figures.

Card 3/3

TUMANOV, A.T., glav. red.; VYATKIN, A.Ye., red.; GARBAR, M.I., kand. tekhn. nauk, red.; ZAYMOVSKIY, A.S., red.; KARGIN, V.A., red.; KISHKIN, S.T., red.; KISHKINA-RATNER, S.I., doktor tekhn. nauk, red.; PANSHIN, B.I., kand. tekhn. nauk, red.; ROGOVIN, Z.A., doktor khoz. nauk, red.; SAZHIN, M.P., red.; SKLYAROV, N.M., doktor tekhn.nauk, red.; FRIDLYANDER, I.N., doktor tekhn. nauk, red.; SHUBNIKOV, A.V., red.; SHCHERBINA, V.V., doktor geol.-miner. nauk, red.; SHRAYBER, D.S., kadn. tekhn.nauk, red.; GENEL', S.V., kand. tekhn.nauk, red.; NOVIKOV, A.S., doktor khoz. nauk, red.; KITAYGORODSKIY, I.I., doktor tekhn. nauk, red.; ZHEREBKOV, S.K., kand. tekhn. nauk, red.; BOGATYREV, P.M., kand. tekhn. nauk, red.; BUROV, S.V., kand. tekhn. nauk, red.; POTAK, Ya.M., doktor tekhn. nauk, red.; KUKIN, G.N., doktor tekhn. nauk, red.; KOVALEV, A.I., kand. tekhn. nauk, red.; ZENTSEL'SKAYA, Ch.A., tekhn. red.

[Building materials; an encyclopedia of modern technology] Konstruktsionnye materialy; entsiklopediia sovremennoi tekhniki. Glav. red. Tumanov, A.A. Moskva, Sovetskaia entsiklopediia. Vol.1. Abliatsiia - Korroziia. 1963. 416 p. (MIRA 17:3)

1. Chlen-korrespondent AN SSSR (for Kishkin).

KISHKIN, S.T.

Diffusive mechanism of relaxation of residual stresses and the role of diffusion in the Rebinder effect. Issl. splav. tsvet. met. no.4:39-47 '63. (MIRA 16:8)

(Strains and stresses) (Diffusion)

L 11227-63 EWP(q)/EWT(m)/BDS--AFFTC/ASD--JD

ACCESSION NR: AP3000488 S/0129/63/000/005/0040/0044

AUTHOR: Bokshteyn, S. Z.; Kishkin, S. T.; Nikishov, A. S.; Polyak, E. V.; Solov'yeva, G. G.

TITLE: Aging of plastically deformed alloys

SOURCE: Metallovedeniye i termicheskaya obrabotka metallov, no. 5, 1963, 40-44

TOPIC TAGS: thermomechanical treatment, high temperature, low temperature, heat resistant steel, heat resistant alloy, titanium alloy, aging, mechanical properties, rupture life

ABSTRACT: A review of published reports on thermomechanical treatment of steels and alloys (TMT) indicates that TMT has a beneficial effect on rupture strength only up to a certain temperature. At higher temperatures the diffusion processes which cause softening proceed at a considerably higher rate than in conventionally treated alloys. For instance, an Ni-Cr-W-Mo-Ti-Al alloy [unidentified] after TMT and aging had a rupture life at 850C 30 to 40% lower than conventionally treated alloys, although its tensile strength was 25% higher. At lower service temperatures (550C for Ni-base alloys and 450 to 500C for Ti-base alloys) TMT greatly increases creep strength and rupture life, especially when combined with aging.

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L 11227-63
ACCESSION NR: AP3000488

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The optimum combination of tensile strength, notch toughness, and rupture life for the KhNGGTYuR alloy [Nimonic 80A] is obtained by plastic deformation at 1000 to 1050C with a reduction of ~ 30% followed by aging. The VTZ-1 Ti-base alloy, forged at 920C, water quenched, and aged at 550C for 2 hr, had a tensile strength at room temperature of 145.5 kg/mm^2, elongation of 9.4%, reduction of area of 47%, a notch toughness of 2.0 mkg/cm^2, and a rupture life (at 450C under 52 kg/mm^2 stress) of over 150 hr; corresponding figures for a conventionally treated alloy were 117.0 kg/mm^2, 12%, 34%, 2.9 mkg/cm^2, and 108 hr. Still greater effects can be achieved by two-stage TMT: deformation at 1200C followed by water quenching; reheating to 1000C and a second deformation with a reduction of 5 to 10%, followed by water quenching and aging. After such treatment the alloy had a rupture life of 200 hr at 550C under a stress of 92 kg/mm^2 and 100 hr at 650C under a stress of 62 kg/mm^2; corresponding figures for conventionally treated alloys were 3 to 7 hr and 60 hr. Combined treatment of the 1Kh12N2VMF steel (forging with 60% reduction at 1010C, water quenching, sizing at 600C with 5 to 10% reduction, combined with aging for 2 hr) increased the tensile strength at 20C by 40% and at 450C by 60%, and the rupture life (at 450C under a stress of 75 kg/mm^2) by 250%. Orig. art. has: 4 figures and 3 tables.

ASSOCIATION: none

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BOKSHTEYN, S.Z.; BRONFIN, M.B.; KISHKIN, S.T.; MARICHEV, V.A.

Internal friction of deformed molybdenum and its alloys with zirconium and rhenium. Fiz. tver. tela 5 no.11:3075-3080 N '63. (MIRA 16:12)

ACCESSION NR: AT4013931 S/2659/63/010/000/0081/0086

AUTHOR: Blistanov, A. A.; Bokshteyn, S. Z.; Gudkova, T. I.; Zhukhovitskiy, A. A. Kishkin, S. T.

TITLE: Investigation of the influence of stress on pore formation

SOURCE: AN SSSR. Institut metallurgii. Issledovaniya po zharoprochny*m splavam, v. 10, 1963, 81-86

TOPIC TAGS: pore formation, high temperature stress, external stress, strain, cracking, brass, alloy structure

ABSTRACT: Pores arise from the coagulation of vacancies produced in the crystal lattice by high temperatures and the effect of external stress and plastic deformation. There is very little information in the world literature on the various factors affecting pore formation, and most of the work which has been done is qualitative in nature. There has been little theoretical work with a quantitative approach, and no experimental work, despite the importance of the subject. The present investigation considered the main laws of pore distribution, the influence of external factors on pore formation, the relationship between pore formation and the structure of the specimen, and the mechanism

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ACCESSION NR: AT4013931

of the formation of pores and cracks in the presence or absence of external factors. Experiments were carried out on α -brass annealed for 50 hrs. at 800C, electropolished, heated by diffusion and then subjected to density determination and examination of the microstructure. The results corroborated the main laws of pore distribution near the sample surface, but showed that the distribution often differed from that predicted on the basis of the laws of diffusion. A theoretical analysis is carried out of the nature of pore distribution at varying depths in the specimen, yielding a calculated curve with a maximum pore density which agreed well with the experimentally determined curve for brass. In polycrystalline brass, pore formation takes place primarily as the result of the limited diffusion of zinc, with volume diffusion playing an increasing role at high temperatures. External stress was found to play an important role in accelerating pore formation and development along the grain boundaries. Under the influence of stress, the energy of activation for pore formation was increased to 26 kcal/gram-atom. It was thus of the same order of magnitude as the energy of activation of diffusion of the volatile component along the grain boundaries. It is suggested that at high temperatures cracks develop mainly as the result of destruction of material remaining between the pores, while at low temperatures the principal process is pore coagulation. The role of impurities in pore formation and their effect in determining the pore distribution is pointed out. A theoretical evaluation of the role of the grain boundaries in pore formation, using the

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ACCESSION NR: AT4013931

Fisher formula, showed that the grain boundaries are the principal channels along which the movement of the volatile component takes place. Orig. art. has: 3 figures and 1 formula.

ASSOCIATION: Institut metallurgii AN SSSR (Metallurgical Institute, AN SSSR)

SUBMITTED: 00 DATE ACQ: 27Feb64 ENCL: 00

SUB CODE: MM NO REF SOV: 000 OTHER: 000

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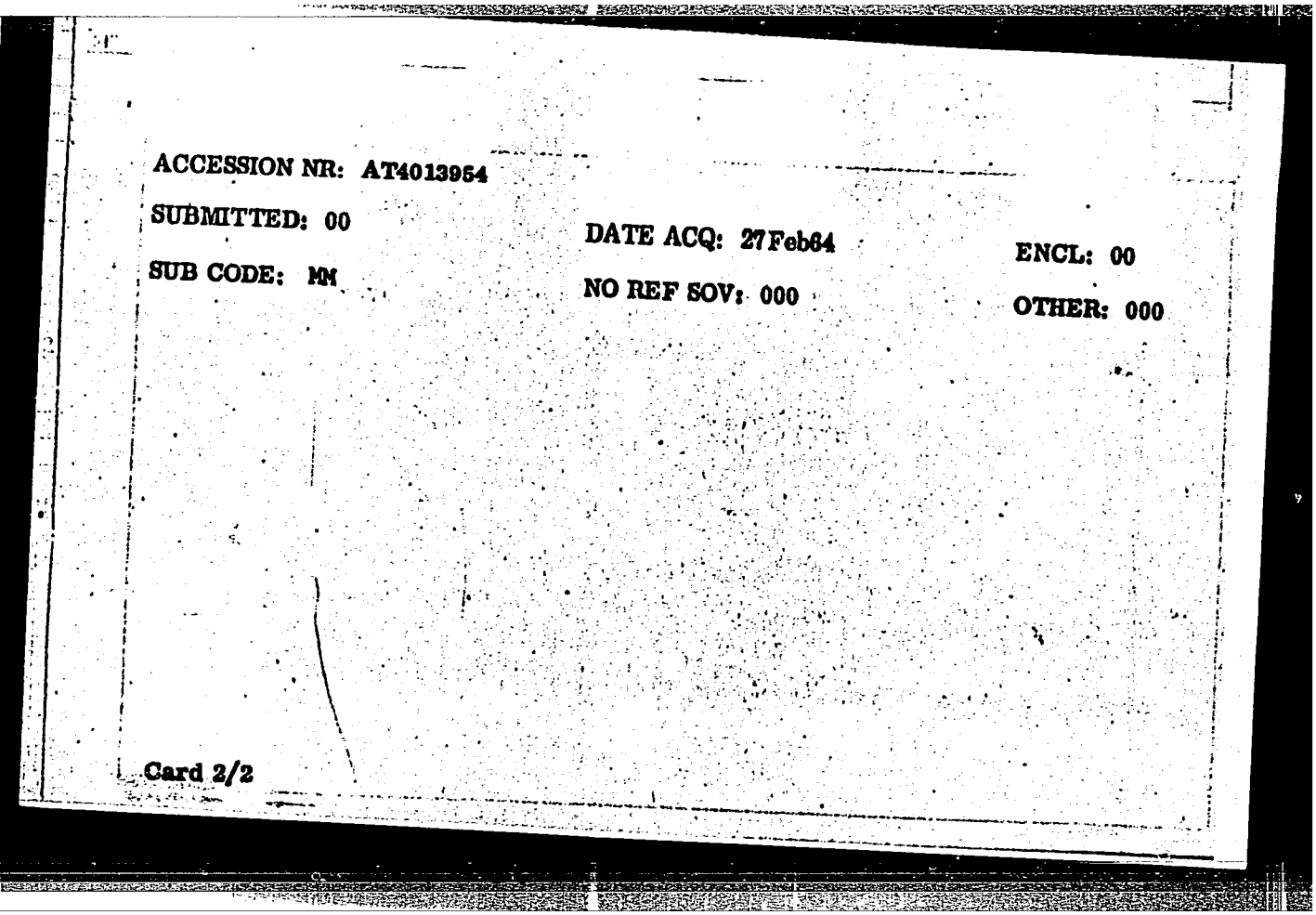

ACCESSION NR: AT4013954

SUBMITTED: 00 DATE ACQ: 27Feb64 ENCL: 00

SUB CODE: MM NO REF SOV: 000 OTHER: 000

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ACCESSION NR: AT4040405 S/0000/64/000/000/0025/0035

AUTHOR: Bokshteyn, S. Z.; Bronfin, M. B.; Kishkin, S. T.

TITLE: Surface and bulk diffusion of tungsten in molybdenum

SOURCE: Protsessy* diffuzii, struktura i svoystva metallov (Diffusion processes, structure and properties of metals); sbornik statey. Moscow, Izd-vo Mashinostroyeniye, 1964, 25-35

TOPIC TAGS: tungsten, molybdenum, surface diffusion analysis, bulk diffusion analysis, autoradiographic analysis method, activity curve analysis method, diffusion coefficient, diffusion equation, diffusion activation entropy, vacancy formation energy

ABSTRACT: The radioactive isotope W^{185} was electroplated on fine-grained flat plates of Mo for autoradiographic analyses of bulk diffusion and surface diffusion, as well as on coarse-grained cylindrical samples for bulk diffusion analyses based on displacements of activity curves. Diffusion coefficients were determined for all samples (see Table 1 in the Enclosure) and further processing yielded the equations

$$D = 3.18 \exp\left[-(112900 \pm 1000)/RT\right] cm^2/sec$$

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ACCESSION NR: AT4040405

for bulk diffusion and

$$D_{surf} = 1.1 \exp(-77000/RT) cm^2/sec$$

for surface diffusion. It is concluded that the entropy of activation of Mo self-diffusion is greater than zero, in agreement with Zener's theory of D_0 for atomic diffusion, and approximate values for the entropy of activation of W diffusion in Mo. Energy of vacancy formation Q_0 = 36 kcal/g-atom, ratio Q_0/Q_{diff} = 0.3 to 0.4 (0.32 for Mo, 0.39 for Cr). Orig. art. has: 8 formulas, 4 figures and 4 tables.

ASSOCIATION: none

SUBMITTED: 09Dec63 DATE ACQ: 28May64 ENCL: 02

SUB CODE: MM NO REF SOV: 011 OTHER: 012

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ACCESSION NR: AT4040405 ENCLOSURE: 01

Table 1. Diffusion coefficient in $cm^2/sec.$ for diffusion of W in No.

Temp. of diffusion annealing in °C	1700	1750	1830	1850	1880	1900
Bulk diffusion, activity curve displacement analysis (hrs.)	———	———	5.8×10^{-12} (47.5)	———	1.1×10^{-11} (109.5)	———
Bulk diffusion, autoradiographic analysis (hrs.)	9.9×10^{-12} (112)	2.0×10^{-12} (108)	———	8.9×10^{-12} (103)	———	1.2×10^{-11} (99)
Intercrystalline diffusion	———	5.4×10^{-9}	———	1.3×10^{-8}	———	2.0×10^{-8}

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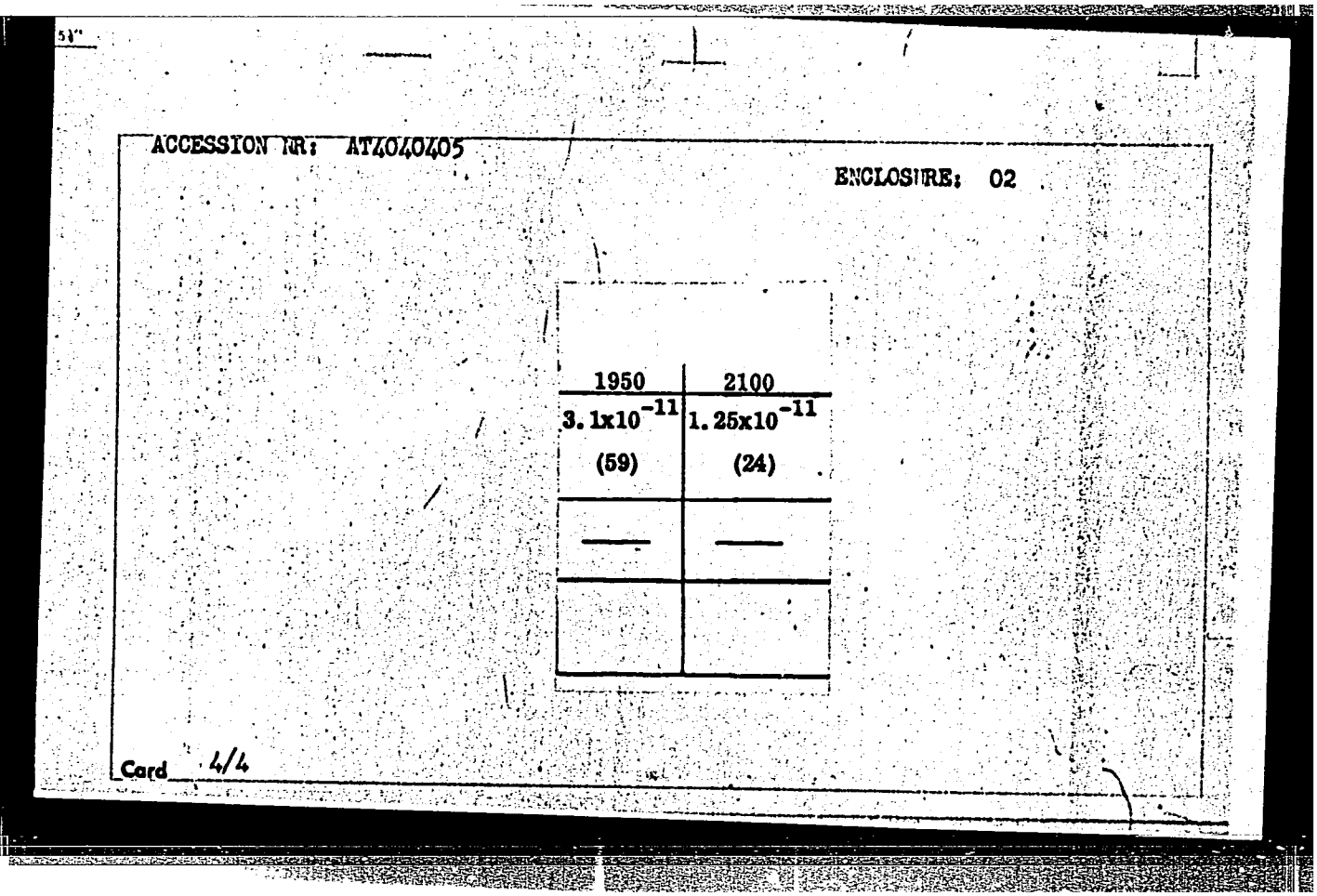

ACCESSION NR: AT4040405

ENCLOSURE: 02

1950	2100
3.1×10^{-11} (59)	1.25×10^{-11} (24)
—	—

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ACCESSION NR: AT4040407 S/0000/64/000/000/0040/0051

AUTHOR: Bokshteyn, S. Z.; Bronfin, M. B.; Kishkin, S. T.; Marichev, V. A.

TITLE: Investigation of conditions at the grain boundaries in molybdenum and its alloys with zirconium and rhenium by the method of internal friction

SOURCE: Protsessy* diffuzii, struktura i svoystva metallov (Diffusion processes, structure and properties of metals); sbornik statey. Moscow, Izd-vo Mashinostroyeniye, 1964, 40-51

TOPIC TAGS: molybdenum, molybdenum alloy, molybdenum grain boundary, molybdenum rhenium alloy, molybdenum zirconium alloy, rhenium, zirconium, internal friction, stress relaxation, alloy diffusion.

ABSTRACT: The mechanism of stress relaxation at the grain boundaries in pure metals is known to be affected by the presence of alloying elements, but precisely how is still unclear. The study of internal friction, based on measurement of the forced oscillation dampening of a polycrystalline specimen is a sensitive method for investigation of the structural conditions of a metal generally, and particularly at the grain boundaries. The present authors experimented with specimens of 99.98% pure sintered molybdenum; a Mo - Zr alloy containing 0.13% Zr,

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0.008% C, 0.006% O_2, and 0.0007% H_2; and Mo + 50% Re. The specimens were subjected to torsional oscillations (0.3-0.4 cycles/sec.) at various temperatures in a range of about 20 - 1000C, after annealing at temperatures up to 2000C. The test installation was originally developed by V. B. Osvenskiy and is shown schematically in modified form, in Fig. 1 of the Enclosure. The activation energy H of internal friction was determined from the expression

$$\log Q^{-1} = \log \frac{\Delta M}{\omega \tau_0} - 0.4346 \frac{H}{RT}$$

under the assumption that $\log \frac{\Delta M}{\omega \tau_0} = \text{const}$. Fig. 2 of the Enclosure shows the temperature dependence of Q^{-1} for the 3 materials compared. The results showed that the boundary relaxation begins to grow at different temperatures in different alloys. Thus, this temperature is 700C for the Mo-Re alloy and about 600C for pure molybdenum or Mo + 0.13% Zr. Beginning at 700C, the highest level of internal friction is shown by unalloyed molybdenum; the lowest - by its alloy with 50% rhenium. If the internal friction along the grain boundaries depended only on the activation energy, it should be maximal in the Mo-Zr alloy, and not in

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ACCESSION NR: AT4040407

pure molybdenum. A mechanism of boundary relaxation is therefore suggested which is connected with a migration of interstitial solutes such as oxygen, carbon and nitrogen. This migration requires less energy than the displacement of the diffusionally more inert atoms normally occupying the nodal points in the lattice. This could explain the relatively low activation energy of internal friction found at the grain boundaries. Qualitatively, the influence of diffusional replacement components can be explained by the mutual interaction between these components and the migrating atoms of penetrating components, as well as the ability of the replacement components to alter the structural imperfections in intergranular zones. "The authors express thanks to Ye. M. Savitskiy and M. A. Ty*lkina for supplying the Mo-Re alloy." Orig. art. has: 5 figures and 4 formulas.

ASSOCIATION: None

SUBMITTED: 09Dec63

SUB CODE: MM

ENCL: 02

NO REF SOV: 003

OTHER: 005

Card 3/5

ACCESSION NR: AT4040411 S/0000/64/000/000/0074/0094

AUTHOR: Bokshteyn, S. Z.; Kishkin, S. T.; Moroz, L. M.

TITLE: Investigation of the conditions of the grain boundaries during recrystallization of iron and its alloys

SOURCE: Protsessy* diffuzii, struktura i svoystva mettallov (Diffusion processes, structure and properties of metals); sbornik statey. Moscow, Izd-vo Mashinostroyeniye, 1964, 74-94

TOPIC TAGS: iron, iron alloy, steel, tungsten steel, carbon steel, steel structure, grain boundary, recrystallization, iron microstructure, carbon diffusion, tungsten diffusion, tin diffusion, nickel diffusion

ABSTRACT: There are still unclear aspects of the mechanism of recrystallization, such as the nature of the reconstruction of grain boundaries, the formation of new grains and their subsequent growth, the influence of impurities, and the role of diffusion. The present authors investigated recrystallization of iron in specimens previously subjected to a plastic deformation of 10-16 and 45-70%, involving a variety of heat treatments (annealing at 720-800C, recrystallization at 700-1370C, additional heating at 700-950C). Data on microhardness before and after these processes are tabulated. Furthermore, recry-

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showed that atoms of soluble impurities (nickel, tungsten, tin), like the atoms of the base-metal, practically remain at their initial locations despite significant changes in the microstructure of the metal. Prolonged annealing at recrystallization temperature (78 hrs. at 700C for iron with nickel; 30 hrs. for iron with tin; 28 hrs. at 750 C for iron with tungsten), heating at temperatures above the A_3-point, or high-temperature annealing (30 min. at 1200 C for iron with tungsten) did not cause atomic migration of impurities from the initial locations toward the boundaries of the recrystallized grains, regardless of the degree of prior deformation. During recrystallization, atoms of impurities which were located at the grain boundaries and formed part of the solid solution by penetration showed a substantially different behavior than atoms of base-metal at the boundaries or atoms of impurities forming part of the solid solution by replacement. Carbon atoms, unlike atoms of iron, tungsten, nickel, and tin, follow behind the boundaries of newly forming grains, so that at certain stages of the process a lag may occur due to a difference between the diffusion velocity of carbon and the recrystallization velocity. It is characteristic that carbon atoms always migrate toward the grain boundaries, and not in the direction of the maximum concentration gradient of the impurity. The authors suggest, in conclusion, that the activation energy of the migration process be determined and compared with the activation energy of the diffusion process of carbon in iron. Orig. art. has: 25 photomicrographs and 3 tables.

ASSOCIATION: None

ACCESSION NR: AT4040413 S/0000/64/000/000/0099/0109

AUTHOR: Bokshteyn, S. Z; Kishkin, S. T.; Moroz, L. M.; Chaply*gina, V. S.

TITLE: Structure imperfections of metal following recrystallization

SOURCE: Protsessy* diffuzii, struktura i svoystva metallov (Diffusion processes, structure and properties of metals); sbornik statey. Moscow, Izd-vo Mashinostroyeniye, 1964, 99-109

TOPIC TAGS: metal structure, metal diffusion, diffusion permeability, metal recrystallization, iron, tin, tungsten, carbon diffusion

ABSTRACT: Many of the properties and processes occurring in metals depend upon the degree of structural perfection. However, it is not clear how and under what circumstances structural defects arise or disappear. In some cases, it has been possible to achieve a displacement of interstitial impurities into the inner regions of grains by recrystallization, thus increasing the plasticity of the alloys. However, such a beneficial influence of recrystallization has been observed only in individual cases. Therefore, the assumption can be made that in regions where grain boundaries have been located before recrystallization, preservation of the specific state is possible, i.e., there is a possibility

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ACCESSION NR: AT4040413

of "heredity". In the present paper, the authors investigated the heredity of metal structure during recrystallization and grain growth, using autoradiographic and microscopic techniques. The degree of structural perfection was evaluated by diffusion permeability of C14, a higher permeability corresponding to a more defective structure. Using specimens of pure iron and of iron containing diffusionally introduced interstitial additions, such as tin and tungsten, the authors studied the stability and degree of defectiveness of the original grain boundaries during recrystallization in relation to the degree of metal purity and the recrystallization conditions. Iron was annealed at 1250C for 9 hrs., electropolished and etched with 4% picric acid in ethanol to reveal the structure. Tin and tungsten were added in a microfurnace at 700C. Recrystallization was then carried out either at 650C for 45 min., at 700C for 30 min. or at 750C for 1 hr., followed by heating at 600C for 1 hr. in the presence of radioactive carbon. Measurements of hardness and C14 distribution demonstrated that diffusion is affected by recrystallization temperature and that the residual effects of previous cold working can remain after application of the common types of recrystallization. The diffusional mobility of atoms was found to increase during the process of recrystallization. Failure of alloys at high temperatures generally proceeds along the grain boundaries, but sometimes it occurs transgranularly. It is possible that, in the latter case, the alloy fails along the boundaries of original

ACCESSION NR: AT4040413

grains which were metallographically undetectable. The question of the influence of various impurities on the defectiveness of the original grain boundaries thus gains considerable significance. It is very possible that inheritance of defectiveness is linked to a considerable degree to the presence of impurities; therefore, the question arises of the possibility of displacing the impurities from the boundaries to the inner region by recrystallization. The results of the present investigation permit the authors to assume that the detrimental influence of impurities can be reduced by applying suitable recrystallization conditions. Orig. art. has: 7 figures and 1 table.

ASSOCIATION: none

SUBMITTED: 09Dec63 DATE ACQ: 28May64 ENCL: 00

SUB CODE: MM NO REF SOV: 002 OTHER: 000

Card 3/3

ACCESSION NR: AT4040417 S/0000/64/000/000/0133/0146

AUTHOR: Blistanov, A.A.; Bokshteyn, S.Z.; Gudkova, T.I.; Kishkin, S.T.; Zhukhovitskiy, A.A.

TITLE: Pore formation and rupture at high temperatures in relation to stress and metal structure

SOURCE: Protsessy* diffuzii, struktura i svoystva metallov (Diffusion processes, structure and properties of metals); sbornik statey. Moscow, Izd-vo Mashinostroyeniye, 1964, 133-146

TOPIC TAGS: alpha brass, nichrome, nickel based alloy, alloy pore formation, volatile constituent diffusion, grain boundary effect, stress effect, metal structure effect, high temperature failure, metal failure analysis

ABSTRACT: This study concerned the kinetics of pore formation, as well as the effects of stress, temperature and structure of the metal on such processes in relation to failure of the metal at high temperatures. Sheet samples of alpha brass (32% Zn and 68% Cu; annealed 50 hrs. at 800C and 0.01 mm Hg) and a Nichrome alloy (20% Cr, 80% Ni; prehomogenized

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ACCESSION NR: AT4040417

50 hrs. at 1200C in argon) were polished electrolytically, then homogenized in a vacuum (residual pressure 0.001 mm Hg, temp. 500-1250C, volatile component distillation) under stresses varying from 15 to 120 kg/cm^2 or unstressed. Results obtained with the brass samples indicate that pore formation is initiated due to evaporation and the accompanying diffusive migration of constituents. The effect of grain boundaries is not apparent in the initial stages, but becomes clearly pronounced as the process continues. Pores form earlier as temperature rises. The presence of stress accelerates the process and the effect of grain boundaries rises sharply. The process is completed by cracking and rupture along the grain boundaries. Pore formation was absent in unstressed nichrome, while stressed samples showed significant porosity, cracks and eventual failure, mainly along the grain boundaries. Other experiments indicate that heterogeneity of the material significantly affects patterns of pore distribution. It is concluded that similar studies will permit physical analysis of metal failure at high temperatures. Orig. art. has: 4 graphs and 8 photomicrographs.

ASSOCIATION: none

SUBMITTED: 09Dec63
SUB CODE: MM
Card 2/2

DATE ACQ: 28May64
NO REF SOV: 003

ENCL: 00
OTHER: 003

ACCESSION NR: AT4040418 S/0000/64/000/000/0147/0151

AUTHOR: Bokshteyn, S. Z.; Gudkova, T. I.; Zhukhovitskiy, A. A.; Kishkin, S. T.

TITLE: Effect of preliminary deformation on pore formation

SOURCE: Protsessy* diffuzii, struktura i svoystva metallov (Diffusion processes, structure and properties of metals); sbornik statey. Moscow, Izd-va Mashinostroyeniye, 1964, 147-151

TOPIC TAGS: alpha brass, pore formation, preliminary deformation effect, high temperature effect, metal evaporation, alloy failure

ABSTRACT: Cylindrical samples (h = 10 mm) of alpha brass (38% Zn, 62% Cu) were annealed for 3 hrs. at 800C in an argon atmosphere, then pressed at room temperature to deformation levels of 3-5%, 15-20% and 55-60%. The effect of preliminary deformation on evaporation was evaluated from changes in sample weight during subsequent vacuum homogenizing (4 hrs. at 700, 800 or 850C). It was found that preliminary plastic deformation increased the rate of evaporation, as well as the number and size of pores forming at high temperatures. The effect was most pronounced at deformation levels of 10% or less and

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ACCESSION NR: AT4040418

decreased at higher levels or as temperature increased. Orig. art. has: 4 graphs.

ASSOCIATION: none

SUBMITTED: 09Dec63 DATE ACQ: 28May64 ENCL: 00

SUB CODE: MM NO REF SOV: 000 OTHER: 000

Card 2/2

ACCESSION NR: AT4040419 S/0000/64/000/000/0155/0167

AUTHOR: Bokshteyn, S. Z.; Kishkin, S. T.; Svetlov, I. L.

TITLE: A study of the mechanical properties of Cu, Ni and Co whiskers

SOURCE: Protsessy* diffuzii, struktura i svoystva metallov (Diffusion processes, structure and properties of metals); sbornik statey. Moscow, Izd-vo Mashinostroyeniye, 1964, 155-167

TOPIC TAGS: copper whisker crystal, nickel whisker crystal, cobalt whisker crystal, whisker tensile strength, whisker structural defect, whisker alloying effect, whisker diameter effect, whisker microcrystalline dislocation, selective etching procedure

ABSTRACT: Whiskers of Cu, Ni and Co (length = 1.5-3 mm, diameter = 2-15μ), grown by hydrogen reduction of anhydrous haloid salts, were tested for tensile strength in relation to crystal diameter and orientation of its long axis, as well as for variation in strength lengthwise and the effect of alloying (diffusive saturation of Cu with Ag) on mechanical properties. Selective etching was used to expose microcrystalline dislocations in the Cu. The results indicate substantial divergence in relation to diameter, especially for very small diameters of 2 - 3 μ. Empirical relationships were derived between diameter and tensile strength,

Card 1/2

KISHKIN, S. T.

ACCESSION NR: AT4040421 S/000/64/000/000/0177/0182

AUTHOR: Bokshteyn, S. Z.; Glazunov, S. G.; Yemel'yanova, T. A.; Kabanov, Yu. N.; Kishkin, S. T.; Mirskiy, L. M.

TITLE: Thermomechanical treatment of titanium alloys with β-structure

SOURCE: Protsessy* diffuzii, struktura i svoystva metallov (Diffusion processes, structure, and properties of metals); sbornik statey. Moscow, Izd-vo Mashinostroyeniye, 1964, 177-182

TOPIC TAGS: titanium alloy, beta structure, mechanical property, thermomechanical treatment, thermomechanical treatment effect

ABSTRACT: The effect of thermomechanical treatment on the mechanical properties of β-titanium alloys VT15 (3.76% Al, 7.80 Mo, 10.7% Cr) and V-120 (US alloy, 3.1% Al, 11.6% Cr, 12.6% V) were investigated. Alloy specimens were held at 760C for 30 minutes, then rolled with a reduction of either 10 or 45% and immediately quenched (high temperature thermomechanical treatment, HTTMT) or they were cooled at 350C, held for 2—3 minutes, rolled with a reduction of 10 or 40%, and

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ACCESSION NR: AT4040421

immediately quenched. In both cases, quenching was followed by aging at 450C for 25 or 50 hr. The mechanical properties of differently treated alloys are shown in Table 1 of the Enclosure. In stress rupture tests [apparently at 400C] under a stress of 100 kg/mm^2, the VT15 alloy had a rupture life of 13.5—15.0 hr, elongation of 17.2—19.0%, and a reduction of area of 49.0—51.5% after HTTMT. The V-120 alloy similarly treated had a rupture life of 97—100 hr. Orig. art. has: 5 figures and 4 tables.

ASSOCIATION: none

SUBMITTED: 09Dec63 ATD PRESS: 3049 ENCL: 01

SUB CODE: MM NO REF SOV: 000 OTHER: 001

Card 2/3

ACCESSION NR: AT4040422 S/0000/64/000/000/0183/0187

AUTHOR: Bokshteyn, S. Z.; Kishkin, S. T.; Moroz, L. M.

TITLE: Effect of thermomechanical treatment on diffusion mobility

SOURCE: Protsessy* diffuzii, struktura i svoystva metallov (Diffusion processes, structure and properties of metals); sbornik statey. Moscow, Izd-vo Mashinostroyeniye, 1964, 183-187

TOPIC TAGS: thermomechanical treatment, diffusion mobility, diffusion coefficient, fine structure, diffusion mobility determination, thermomechanical treatment effect

ABSTRACT: The diffusion mobility of iron in austenitic steel EI481 and EI437B alloy were investigated after conventional heat treatment and after thermomechanical treatment (TMT). The parameters of the latter treatment were: 1080C - temperature of deformation; 28% - reduction; and 13.5 m/min - deformation rate. The diffusion mobility was determined by the method of tagged atoms in combination with microstructure analysis. The specimens were electrolytically coated

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ACCESSION NR: AT4040422

with a thin film of radioactive Fe^{59} and annealed in a vacuum furnace at 800C for 150 hr. After annealing, the diffusion coefficients were calculated for grain volume and grain boundaries. Table 1 (see enclosure) presents the results obtained. Thus, TMT changes not only the conditions of the grain boundaries, but of the grain bodies as well. The increase of diffusion mobility is preserved even after annealing at higher temperatures (temperature of recrystallization). The increase of diffusion mobility produced by TMT limits the applicability of this method for heat-resistant alloys. TMT could be beneficial, however, for alloy working at relatively low temperature. Orig. art. has: 4 figures and 2 tables.

ASSOCIATION: none

SUBMITTED: 09Dec63 ATD PRESS: 3072 ENCL: 01

SUB CODE: MM NO REF SOV: 001 OTHER: 00

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ACCESSION NR: AT4040422 ENCLOSURE: 01

Table 1. Iron diffusion coefficients D·10 cm /sec on grain boundaries Dgr and in grain bodies Db of alloys EI437B and EI481 at 800C

Alloy	Conventional heat treatment		TMT	
	Dgr	Db	Dgr	Db
EI481	0.62	4.6	2.8	–
EI437B	0.87	3.5	1.7	11
Average diffusion coefficient				
EI481	1.4		3.0	
EI437B	1.0		1.3	

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ACCESSION NR: AP4037065 S/0129/64/000/005/0021/0028

AUTHOR: Drozdovskiy, B. A.; Pevzner, L. M.; Tarantova, A. S.; Fridman, Ya. B.; Kishkin, S. T.

TITLE: Effect of carbon content on the tensile strength of structural steel sheets

SOURCE: Metallovedeniye i termicheskaya obrabotka metallov, no. 5, 1964, 21-28

TOPIC TAGS: high strength steel, superstrength steel, medium alloy steel, VKS-1 steel, solid fuel rocket, rocket case, rocket case material, steel notch sensitivity

ABSTRACT: The effects of carbon content, melting conditions, and heat treatment conditions (primarily tempering temperature) on the strength and ductility (in conventional tensile tests and under biaxial tension), and notch sensitivity of two superstrength steels VKS-1 and [AISI]4137-Co are investigated. Four grades of VKS-1 (0.30, 0.39, 0.45, or 0.53% carbon; 0.89% manganese; 1.2% silicon; 1.87% chromium; 0.72% nickel; 0.49% molybdenum; 0.05% vanadium; 0.011% sulfur; and 0.008%

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ACCESSION NR: AP4037065

phosphorus) were melted in an open atmosphere induction furnace. The 4137-Co (0.40% carbon, 0.84% manganese, 1.02% silicon, 1.32% chromium, 0.36% molybdenum, 0.19% vanadium, and 1.1% cobalt) was melted either in an open atmosphere induction furnace or in a consumable electrode vacuum arc furnace. Both steels were rolled into sheets 1 mm (VKS-1) or 1.5 mm (4137-Co) thick. Special care was taken to prevent surface decarburization. Tests revealed that tensile and yield strength of VKS-1 steel increased steadily with increased carbon content up to 0.45%. Steel with 0.45% carbon tempered at 150C has a tensile strength of 240—245 kg/mm^2 but low ductility and a high notch sensitivity. When tempered at 220C the steel had a tensile strength of 220—230 kg/mm^2, yield strength of 180 kg/mm^2, and elongation 6.5%. Further increase of carbon content brings about premature brittle failures. Elongation remains almost unaffected by increase of carbon content from 0.30 to 0.45% but notch sensitivity increases very sharply. Under conditions of biaxial tension the strength of VKS-1 increased with higher carbon content only up to 0.39%. With 0.30—0.39% carbon the fracture is ductile and the strength is higher than that in uniaxial tension. As the carbon content is increased to 0.45% the fracture becomes brittle, the

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ACCESSION NR: AP4037065

strength drops and goes below the level noted in uniaxial tension. Generally, the maxima on the strength-carbon content or strength-tempering temperature curves for biaxial tension do not coincide with those for uniaxial tension but occur at carbon contents and tempering temperature at which the strength in uniaxial tension amounts to about 200 kg/mm^2. The behavior of 4137-Co steel followed a similar pattern. It was found, however, that vacuum arc melting improved ductility, especially in biaxial tension, and lowered notch sensitivity. No brittle failures were observed even at tempering temperature as low as 150C. No correlation between the strength in biaxial tension and any characteristics in uniaxial tension was found in either steel. It is concluded that the problem of improvement of structural strengtn is closely related to the prevention of brittle fracture at higher uniaxial strength. This can be achieved by complex alloying with a minimum segregation of components; improved metallurgical processes ensuring higher purity of metal; control of solidification processes to prevent microsegregation and improve the strength of interdendritic boundaries; and finally by thermomechanical treatment with a maximum grain refinement.

Card 3/4

L 10426-65 EWT(m)/EPF(n)-2/T/EWP(b) Pad/Pu-4 ASD(m)-3 MJW/JD/HW/JG

ACCESSION NR: AT4044750 S/2535/64/000/158/0014/0019

AUTHOR: Kishkin, S. T. (Doctor of technical sciences); Kly*pin, A. A. (Candidate of technical sciences)

TITLE: Effect of short overheatings on properties of heat-resistant alloys

SOURCE: Moscow. Aviatsionny*y institut. Trudy*, no. 158, 1964. Issledovaniya struktury* i svoystv zharoprochny*kh splavov (Studies on the structure and properties of heat-resistant alloys), 14-19

TOPIC TAGS: heat resistant alloy, nickel base alloy, EI437 alloy, nickel alloy overheating, cold worked alloy property, overheated complex alloy property, nickel alloy heat resistance, nickel alloy rupture life

ABSTRACT: The effect of short overheatings on the EI437 heat-resistant nickel-base alloy (Nimonic 80) has been studied. It was found that overheating of a heat-treated (annealed and aged) alloy to temperatures up to 800C has no effect on hardness, but at 900—1300C the

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ACCESSION NR: AT4044750

hardness drops sharply from approximately 300 HV to 155 —180 HV in the first 10 sec of exposure. A longer exposure has little or no additional effect. The 1000-sec exposure at 700—1100C decreases strength and increases ductility. This is apparently due to the dissolution of particles of the strengthening phase and their coagulation. Stress rupture tests at 700C under a stress of 36 kg/mm^2 showed that specimens exposed to 800, 900, or 1000C for 1000 sec had a rupture life of 40, 24, and 16 hr, respectively, compared to 100 hr for specimens which were not overheated. Ductility of overheated specimens was greatly increased. Thus, even overheating to 800C shortens the rupture life of the alloy, although its hardness remains unchanged. On the contrary, overheating of the strain-hardened alloy prolongs its rupture life. The effect of short overheatings in both aging and nonaging nickel alloys can be minimized by the addition of chromium, molybdenum, and tungsten which substantially strengthen solid solution, especially in the presence of phases which strengthen the alloy during aging. The strength of the EI437 alloy to which cobalt, molybdenum, and tungsten have been added begins to decrease at higher temperatures than that of the same alloy without these elements. A complex heat-

L 10416-65
ACCESSION NR: AT4044750

resistant alloy with Mo, W, and Co is much less affected by short overheatings. Its hardness increases with exposures of up to 200 sec and begins to decrease only after longer exposure. Orig. art. has: 4 figures.

ASSOCIATION: Moskovskiy aviatsionnyy institut (Moscow Aviation Institute)

SUBMITTED: 00 ATD PRESS: 3110 ENCL: 00

SUB CODE: MM NO REF SOV: 002 OTHER: 000

Card 3/3

L 12449-65 EWT(1)/EPA(s)-2/EWT(m)/EWP(w)/EPF(n)-2/EWA(d)/EWP(t)/EPA(bb)-2/EWP(b)
Pad/Pt-10/Pu-4 ASD(m)-3 MJW/JD/WW/HW/JG/WB
ACCESSION NR: AT4044752 S/2535/64/000/158/0029/0034

AUTHOR: Benediktova, G. P. (Candidate of technical sciences); Kishkin, S. T. (Doctor of technical sciences)

TITLE: The problem of the behavior of heat-resistant alloys stressed while in contact with sodium

SOURCE: Moscow. Aviatsionny*y institut. Trudy*, no. 158, 1964, Issledovaniya struktury* i svoystv zharoprochny*kh splavov (Studies on the structure and properties of heat-resistant alloys), 29-34

TOPIC TAGS: heat resistant alloy, nickel base alloy, alloy strengthening, sodium induced strengthening, nickel base alloy corrosion, sodium induced corrosion

ABSTRACT: The behavior of EI437A, EI437B, and EI617 nickel-base alloys in contact with sodium was investigated in an attempt to determine the mechanism of the strengthening effect sodium has on these alloys. In constant load stress rupture tests at 1000C in air, alloy specimens showed an intensive necking; the true stress and, consequently, creep rate increase rapidly even at relatively low loads. Specimens tested in contact with sodium exhibited no necking, true

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L 12449-65
ACCESSION NR: AT4044752

2

stresses and creep rate grew slowly, and specimens withstood greater loads, and for a longer time, than when tested in air. It was found that the mechanism of strengthening is rather complicated. Some experiments showed that sodium may diffuse into the alloys. On the other hand, some contaminants contained in sodium, such as oxygen and carbon, may react with the alloys, bringing about loss of alloying elements in the surface layers of the alloys or formation of carbides or nitrides in these layers. The strengthening effect, however, is observed at rather short rupture lives on the order of 200 hr. In longer tests, lasting for 500 hr, the strengthening effect is annihilated by corrosion, which is especially intensive in sodium containing some impurities. The corrosion is primarily intergranular and in 500 hr penetrates to a depth of 0.03—0.08 mm, depending on the purity of sodium. Orig. art. has: 3 figures and 1 table.

ASSOCIATION: Moskovskiy aviatsionnyy institut (Moscow Aviation Institute)

SUBMITTED: 00 ATD PRESS: 3127 ENCL: 00

SUB CODE: MM, AS NO REF SOV: 000 OTHER: 000

CARD 2/2

L 41225-65 EWP(m)/EWP(w)/EPF(c)/EWA(d)/EWP(v)/T/EWP(t)/EWP(k)/EWP(z)/EWP(b)/EWA(c)
IAJW/JD/JW/WB/EM

ACCESSION NR: AT4044753 S/2535/64/000/158/0035/0042

AUTHOR: Karyabkina, N. V. (Candidate of technical sciences); Kishkin, S.T. (Doctor of technical sciences)

TITLE: Radiographic study of oxidation and recrystallization processes in the surface zones of nickel-base heat-resistant alloys

SOURCE: Moscow. Aviatsionny y institut. Trudy , no. 158, 1964. Issledovaniya struktury i svoystv zharoprochny kh splavov (Studies on the structure and properties of heat-resistant alloys), 35-42

TOPIC TAGS: nickel alloy, heat resistant alloy, nickel alloy oxidation, nickel alloy recrystallization, radiography, surface oxidation, surface recrystallization / alloy EI437B, alloy EI617

ABSTRACT: The purpose of this investigation was to determine the stability of the surface layers of gas-turbine blades made from cast alloy, alloy EI437B or EI617 with respect to oxidation and recrystallization in the furnace atmosphere. Specimens were heated in a muffle furnace at 650-950C for periods up to 150 hours. The appearance of the first points on the front line was taken as the beginning of oxidation. Resulting data were used to plot curves of stability against oxidation

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L 41225-65
ACCESSION NR: AT4044753

and recrystallization, which showed that the start of oxidation and recrystallization coincides for each alloy; these processes start later at lower temperatures. Cast alloy was the most stable. At higher temperatures, the differences in stability of the different alloys become insignificant. Curves are also presented showing the onset of oxidation as a function of annealing time and, using these, the energies of activation of the recrystallization process were calculated from the formula $\tau_H = \tau \cdot e^{\frac{Q_H}{RT}}$, where H is the time of onset of recrystallization; T is the annealing temperature; τ_0 is a constant coefficient; R is the gas constant; and Q_H is the energy of activation. For alloy EI437B this was 56,000 cal/gm-atom. The authors conclude that oxidation and recrystallization take place simultaneously, but are both limited to the work hardened surface layer. The alloying elements apparently migrate into the oxide layer, and the recrystallized grains show lattice parameters approaching those of pure nickel. "The authors express their gratitude to x-ray technician S.P Kulagin." Orig. art. has: 3 tables, 2 figures and 1 formula.

ASSOCIATION: Moskovskiy aviatsionnyy institut (Moscow aeronautical institute)

SUBMITTED: 00 ENCL: 00 SUB CODE: MM

NO REF SOV: 005 OTHER: 000

Card 2/2

ACCESSION NR: AP4034900 S/0181/64/006/005/1261/1266

AUTHORS: Bokshteyn, S. Z.; Kishkin, S. T.; Nazarova, M. P.; Svetlov, I. L.; Umantsev, E. L.

TITLE: Growth of sapphire whisker

SOURCE: Fizika tverdogo tela, v. 6, no. 5, 1964, 1261-1266

TOPIC TAGS: whisker crystal, crystal growth, sapphire, sapphire whisker

ABSTRACT: Whisker crystals of Al_2O_3 were grown by high-temperature oxidation of powdered metallic Al in an atmosphere of moist hydrogen. The reaction temperature was 1350—1400C. The authors describe a special apparatus used for growing these crystals, which consists of three essential parts: a tubular furnace, a hydrogen source, and a system for purification and control of hydrogen feed. The whisker crystals ranged from 1 to 30 μ in diameter and from 3 to 15 mm in length. Microcrystals ranged from 30 to 350 μ in diameter, and 0.5 to 3 mm in length. Capillaries were observed along the growth axes of some crystals.

Card 1/2

L 56052-65 EWT(m)/EWA(d)/EPR/T/EWP(t)/EWP(z)/EWP(b)/EWA(c) Ps-4 IJP(c)
ACCESSION NR: AP5010555 MJW/JD/JW UR/0129/65/000/004/0036/0038
532.72:669.71'72

AUTHOR: Bokshteyn, S. Z.; Bronfin, M. B.; Kishkin, S. T.; Marichev, V. A.

TITLE: Study of the diffusion of magnesium in aluminum by means of evaporation in a vacuum

SOURCE: Metallovedeniye i termicheskaya obrabotka metallov, no. 4, 1965, 35-38

TOPIC TAGS: magnesium diffusion, aluminum alloy, vacuum evaporation, magnesium containing alloy

ABSTRACT: The diffusion of magnesium in aluminum was studied at 275-425C by evaporation from an open surface. Samples of the Al-Mg alloy AMg6 containing 6.35% Mg were used. As time elapses, the surface layers of the sample become depleted of Mg; a concentration gradient is thus created which causes the migration of magnesium by diffusion from the middle layers to the surface. Subsequently, Mg evaporates at the rate at which it is supplied by this diffusion. The evaporation was determined from the weight loss of the sample, and kinetic curves of the specific weight loss under isothermal conditions were plotted for several temperatures. From these curves, the coefficients of diffusion of magnesium in

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L 56052-65

ACCESSION NR: AP5010555

aluminum were calculated for 275, 300, 350, 375, 400, and 425C by assuming that the diffusion coefficient is independent of the Mg concentration, which is zero at the surface of the sample in the course of the isothermal process. The activation energy of the diffusion of Mg in Al was obtained graphically, and found to be 28.50 kcal/g·at. Orig. art. has: 2 figures, 1 table, and 2 formulas.

ASSOCIATION: None

SUBMITTED: 00 ENCL: 00 SUB CODE: MM, SS

NO REF SOV: 001 OTHER: 003

Card 2/2

BOGSHTEYN, S.Z. (Moskva); KISHKIN, S.T. (Moskva); MARKIN, A.M. (Moskva); TAVADZE, F.N. (Moskva); KHEROD.NASHVILI, Z.Sh. (Moskva)

Diffusive mobility and heat resistance of titanium alloys following thermal and thermomechanical treatments. Izv. AN SSSR. Met. no.5:139-142 S-O '65. (MIRA 18:10)

L 9557-66 EWT(m)/EWA(d)/EWP(t)/EWP(k)/EWP(z)/EWP(b)/EWA(c) MJW/JD/RM

ACC NR: AP5026362 SOURCE CODE: UR/0370/65/000/005/0143/0148

AUTHOR: Braslavskiy, D. I. (Moscow); Kishkin, S. T. (Moscow); Polyak, E. V. (Moscow); Roshchina, I. N. (Moscow); Solov'yeva, G. G. (Moscow); Cherkis, Yu. Yu. (Moscow)

ORG: none

TITLE: Thermomechanical treatment of heat-resistant martensitic steel

SOURCE: AN SSSR. Izvestiya. Metally, no. 5, 1965, 143-148

TOPIC TAGS: steel, heat resistant steel, martensitic steel, mechanical heat treatment, plastic deformation, yield stress, tensile stress /EI961 steel

ABSTRACT: Heat-resistant EI961 steel (0.14% carbon, 10.8% chromium, 1.75% nickel, 1.65% tungsten, and 0.26% vanadium) has been tested for the effect of thermomechanical treatment (TMT). Three variants of TMT were used: 1) high-temperature thermomechanical treatment (HTMT) — plastic deformation at 900—1050C followed by cooling; 2) low-temperature thermomechanical treatment (LTMT) — austenitizing at 100C, cooling to 600C, plastic deformation, and cooling; and 3) combined high- and low-temperature treatment (HLTMT) — plastic deformation at 1050C, cooling, tempering at 580C for 3 hr, plastic deformation at 600C, and cooling. Preliminary experiments showed that optimum reductions for HTMT or LTMT are 20—30% and for HLTMT, 50% at 1050C and 7—10% at 600C. All three variants of TMT considerably improved strength and heat resistance without a significant decrease in ductility. The room-temperature tensile and yield

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UDC: 669.14-157.9

strengths of steel subjected to HTMT, LTMT, and HLTMT increased to 117 and 106 kg/mm^2, 132 and 114 kg/mm^2, and 133 and 118 kg/mm^2, respectively (compared to 108 and 92 kg/mm^2 for conventionally treated steel). Corresponding figures for rupture life at 500C under a stress of 58 kg/mm^2 were 270, 206, and 222 hr (compared to 149 hr for conventionally treated steel). The strengthening effect of HTMT was not annihilated by aging for 100 hr at temperatures up to 550C; that of LTMT was annihilated for the most part by aging at 500C (see Fig. 1). When applied under optimum conditions to ac-

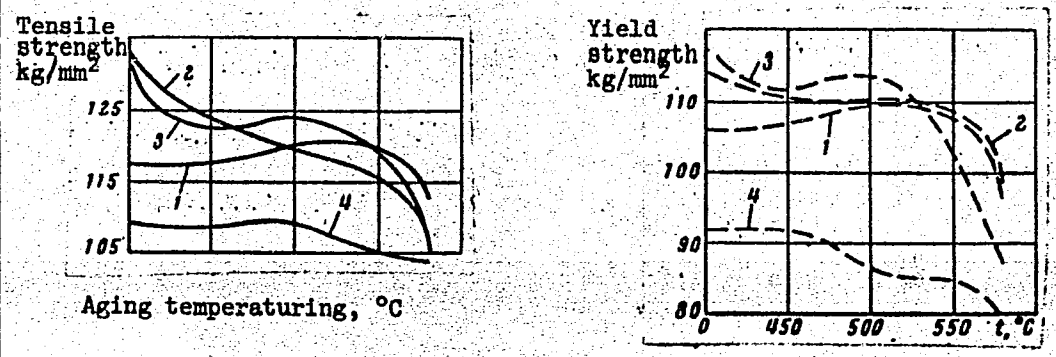

Fig. 1. Effect of 100-hr aging at various temperatures on the tensile and yield strengths of EI961 steel subjected to HTMT (1), LTMT (2), HLTMT (3), and conventional treatment (4)

L 9552-66
ACC NR: AP5026362

tual parts, with the plastic deformation done by die forging, HTMT and HLTMT increased the 100-hr rupture strength at 500C to 62 and 63 kg/mm^2 (from 57 kg/mm^2 for conventionally treated steel) and the fatigue strength at 500C, to 46 and 53 kg/mm^2 (from 35 kg/mm^2 for conventionally treated steel), respectively. HTMT can be used for parts operating at temperatures up to 550C and HLTMT, for parts operating at temperatures up to 500C. LTMT is not recommended for parts operating at elevated temperatures. Orig. art. has: 2 figures and 3 tables. [DV]

SUB CODE: 11,20/ SUBM DATE: 06May65/ ORIG REF: 002/ ATD PRESS: 4150

dek

Card 3/3

L 11202-66 EWT(m)/EWP(t)/EWP(k)/EWP(b)/EWA(c) IJP(c) JD/HW

ACC NR: AP5026361 SOURCE CODE: UR/0370/65/000/005/0139/0142

AUTHOR: Bokshteyn, S. Z. (Moscow); Kishkin, S. T. (Moscow); Mirskiy, L. M. (Moscow); Tavadze, F. N. (Moscow); Kherodinashvili, Z. Sh. (Moscow)

ORG: none

TITLE: Diffusivity and heat resistance of titanium alloys after thermal and thermomechanical working

SOURCE: AN SSSR. Izvestiya. Metally, no. 5, 1965, 139-142

TOPIC TAGS: titanium alloy, carbon alloy, solid mechanical property, metal aging, metalworking, metal diffusion, metal heat treatment, metal forming, thermal aging

ABSTRACT: The effect of standard thermal and thermomechanical working of VT3-1 titanium alloy on carbon diffusivity in alloys and alloy strength was investigated. The standard thermal treatment consisted of heating to 870°C, followed by soaking at 870°C for 1 hour, cooling to 650°C and soaking at 650°C for one hour and air cooling to room temperature. Thermomechanical working consisted of deformation of 30 × 30 × × 65 mm alloy samples at 870°C (60% deformation per hammer strike) and instantaneous quenching in water. This was followed by aging for 5 hours at 550°C. For short and long lasting mechanical strength tests, thermally and thermomechanically worked alloy samples were reduced to 5 mm in diameter. Carbon diffusivity tests were made on 10 × 10 × 20 mm alloy samples. Orig. art. has: 2 figures.

UDC: 669.295.5-157.9

Card 1/3 *Probably BT3-1

L 11202-66

ACC NR: AP5026361

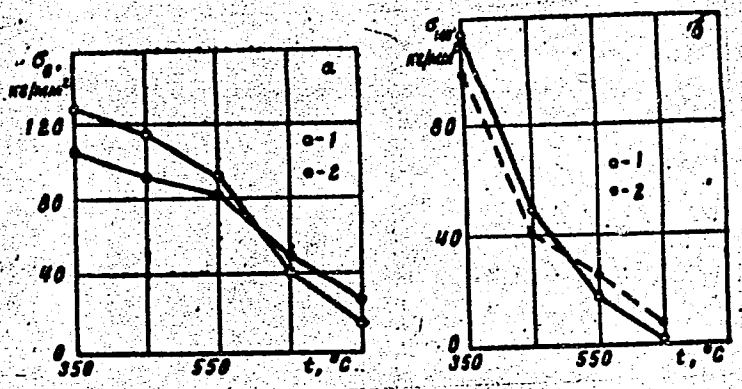

Fig. 1. Effect of temperature on short-lasting strength σ_B and 100-hour linear strength σ_{100} of VTZ-1 alloys after thermomechanical working,(1); After standard thermal working (2).

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L 11202-66
ACC NR: AP5026361

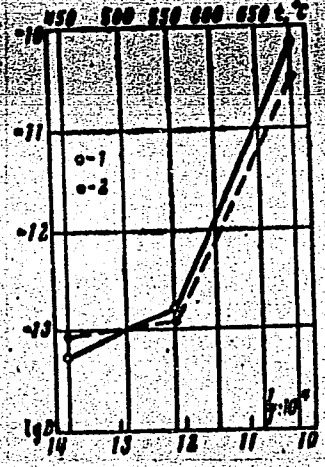

Fig. 2. Temperature dependence of the logarithm of the diffusion coefficient in * VTZ-1 alloy after thermomechanical working (1); after standard thermal working (2).

SUB CODE: 11/ SUBM DATE: 06May65/ ORIG REF: 005/ OTH REF: 000

Card 3/3

L 22543-66 EWT(l)/EWT(m)/T/EWP(t) IJP(c) JD/GG

ACC NR: AP6009644 SOURCE CODE: UR/0181/66/008/003/0688/0695

AUTHOR: Bokshteyn, S. Z.; Kishkin, S. T.; Svetlov, I. L.

ORG: none

TITLE: Influence of orientation, dimension, state of surface, and alloying of filamentary crystals of copper on the form of the deformation diagram in uniaxial tension

SOURCE: Fizika tverdogo tela, v. 8, no. 3, 1966, 688-695

TOPIC TAGS: copper, fiber crystal, stress analysis, plastic deformation, single crystal

ABSTRACT: In view of the fact that no previous tension strain diagrams of filamentary crystals have been made in the past, the authors measured the tension strain diagrams of copper whiskers whose growth direction coincided with the angles of the standard stereographic triangle. The peculiarities of the stress-strain curves of thick whiskers, samples with a silver-surface film, and alloyed whiskers were also investigated. The experimental procedure and the technique of obtaining the strain diagrams was described in detail by the authors earlier (FTT v. 7, 3348, 1965). The dependence of each parameter of the diagram (elastic limit, plastic-flow stress, ultimate strength, hardened coefficients in the linear stage,

Card 1/2

L 22543-66

ACC NR: AP6009644

and duration of the easy slip stage) on the orientation of the whisker relative to the direction of the tensile stress is analyzed separately. The stress-strain curves of ordinary and filamentary single crystals are compared, and it is shown that thin whiskers always display a sharp elastic limit, whose magnitude is 50--300 times higher than the critical cleavage stress. An increase in the density of the structural defects, such as results from alloying, reduces the elastic limit. Another distinguishing feature of the stress-strain curves of whiskers is that even the easy-slip stress exceeds by 10--15 times the torsional stress. No theoretical explanation exists for this latter effect. The interpretation of the test results is made difficult by the lack of precise knowledge of the mechanisms occurring during the three different stages of the stress-strain variation for whiskers (elastic, easy slip, and hardening stages). Orig. art. has: 6 figures, 1 formula, and 3 tables.

SUB CODE: 20/ SUBM DATE: 12Jul65/ ORIG REF: 004/ OTH REF: 005

Card 2/2 BK

L 23718-66 EWT(m)/EWA(d)/EWP(t) LJP(c) JD/WB

ACC NR: AP6013374 SOURCE CODE: UR/0370/66/000/002/0177/0187

AUTHOR: Bokshteyn, S. Z. (Moscow); Bronfin, M. B. (Moscow); Zhukhovitskiy, A. A. (Moscow); Kishkin, S. T. (Moscow); Marichev, V. A. (Moscow)

ORG: none

TITLE: Characteristics of metal sublimation in the presence of an oxidized surface layer

SOURCE: AN SSSR. Izvestiya. Metally, no. 2, 1966, 177-187

TOPIC TAGS: sublimation, vacuum sublimation, magnesium alloy, aluminum alloy, alloy sublimation/VM65-1 alloy, V95 alloy

ABSTRACT: Theoretical and experimental studies have been made of the sublimation and mechanism of the breakdown in the presence of an oxidized surface layer of VM65-1 magnesium-base alloy (5—6% Zn, 0.3—0.9% Zr) and V95 aluminum-base alloy (2.5% Mg and 6% Zn) in a vacuum of 10^{-8} torr at a temperature of 200—380C. It was found that magnesium alloy with a surface oxide film sublimated slowly at 200 or 250C for the first 12—15 hr; then the sublimation rate increased sharply. Specimens which were vacuum annealed at 300C for 4 hr prior to testing sublimated at a high rate from the very beginning of the test (see Fig. 1). The weight of surface-oxidized V95 alloy specimens does not change at 300C for 4 hr. However, at 350C rapid sublimation begins after 10—15 min. Annealing at 340C removes the oxide film, eliminates the inoculation period, and induces rapid sublimation (as in the

Card 1/2 UDC: 669.049.6

L 23718-66
ACC NR: AP6013374

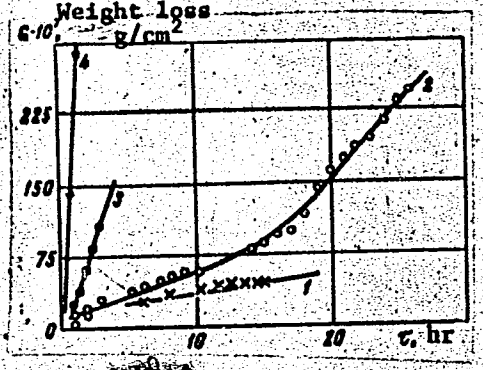

Fig. 1. Sublimation curves of VM65 alloy in vacuum

1 - 200C; 2 - 250C; 3 - 200C; 4 - 250C (3 and 4 after annealing at 300C for 4 hr).

case of VM65 alloy) at the very beginning of the test. The experimental values of the sublimation rate agree well with values obtained from kinetic equations for the sublimation process of tested alloys. Orig. art. has: 7 figures and 26 formulas. [AZ]

SUB CODE: 11, 13/ SUBM DATE: 18Feb65/ ORIG REF: 004/ OTH REF: 004/ ATD PRESS: 4247

Card 2/2

L 29800-66 EWT(l)/EWT(m)/EEC(k)-2/T/EWP(t)/ETI/EWP(k)

ACC NR: AT6016344 (N) SOURCE CODE: UR/0000/65/000/000/0022/0029

AUTHORS: Bokshteyn, S. Z.; Bokshteyn, B. S.; Zhukhovitskiy, A. A.; Kishkin, S. T.; Nechayev, Yu. S.

63

B+1

ORG: none

TITLE: Relaxation method for the study of point defects in the crystal lattice of metals

SOURCE: AN UkrSSR. Podvizhnost' atomov v kristallicheskoy reshetke (Mobility of atoms in crystal lattice). Kiev, Izd-vo Naukova dumka, 1965, 22-29

TOPIC TAGS: metal crystal, crystal lattice, ~~lattice defect~~, crystal lattice defect, ~~electric~~ electric resistance

ABSTRACT: A relaxation method for the study of point defects in metal crystal lattices is presented. The proposed method is particularly suited for the separate determination of the activation energies of vacancy formation Q_f, and vacancy mobility Q_m in metal crystal lattices. The method is based on the determination of the vacancy relaxation time as a function of the temperature

Card 1/3

L 29800-66

ACC NR: AT6016344

$$\left.\begin{aligned} \nu_B &= Z\nu_D \exp(S_m/R)\exp(-Q_m/RT) \\ l^2 &= 4\int_0^{\tau} D_B dt \\ D_B &= \frac{1}{6}\nu_D \delta^2 \exp(S_m/R)\exp(-Q_m/RT) \\ \tau_T &= \frac{3}{2}\cdot\frac{l^2}{\delta^2\nu_D}\exp(-S_m/R)\exp\left(\frac{Q_m}{RT}\right) \end{aligned}\right\};$$

where ν_B is the number of vacancy jumps per second, Z is the coordination number, ν_D is Debye frequency, S_m is entropy of activation for vacancy mobility, l is distance between sources and sinks of vacancies, D_B is diffusion coefficient of vacancies, δ is lattice constant, and n is the number of vacancy jumps during time τ_T. The relaxation time τ_T is determined by measuring the electrical resistance of a metal specimen as a function of time and temperature when the specimen is subjected to rapid heating. The changes in temperature ΔT_2, ΔT_3, etc, corresponding to changes in resistance ΔR_2, ΔR_3, etc for corresponding rates of heating ϑ_2, ϑ_3, etc, are obtained graphically (see Fig. 1). From these τ_T follows as

$$\tau_T = \frac{\Delta T_2}{\vartheta_2} = \frac{\Delta T_3}{\vartheta_3}$$

Card 2/3

L 29800-66

ACC NR: AT6016344

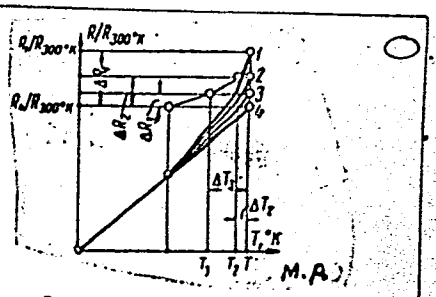

Fig. 1. Temperature dependence of the electrical resistance of metals for different rates of heating. 1 - lattice with equilibrium vacancies concentration, small heating rate; 4 - lattice without vacancies, large heating rate; 2, 3 - intermediate curves.

and Q_m from $\tau r = A \exp(Q_m/RT)$.

The value of Q_f is derived from a graph of $\ln \frac{\Delta R}{R}$ vs $\frac{1}{T}$. The method was tested on aluminum specimens, and a schematic of the experimental installation is presented. It was found that the relaxation time for Al at the melting point was 1.9×10^{-2} sec and $Q_f = 17 \pm 4$ kcal/mole. A variation of the above method affords a study of the kinetics for the reestablishment of equilibrium vacancies concentrations. This method is based on the determination of the change in the electrical resistance $\Delta \rho_1 = \rho_1 - \rho_{01}$, where ρ_{01} is the electrical resistance of an ideal lattice at T_1 and ρ is the equilibrium value of the electrical resistance at T_1

$$\Delta\rho = \Delta\rho_1 [1 - \exp(-t/\tau_{T_1})],$$

Orig. art. has: 7 figures and 4 equations.

SUB CODE: 20/11/ SUBM DATE: 07Dec64

Card 3/3 fv

L 30784-66 EWT(m)/EWA(d)/T/EWP(t)/ETI IJP(c) JD/GS/GD-2

ACC NR: AT6012373 SOURCE CODE: UR/0000/65/000/000/0082/0088

AUTHORS: Kishkin, S. T.; Polyak, E. V.; Solonina, O. P.; Moiseyev, V. N.; Tarasenko, G. N.; Kurayeva, V. P.

ORG: none

TITLE: Structural transformations in titanium alloys

SOURCE: Soveshchaniye po metallokhimii, metallovedeniyu i primeneniyu titana i yego splavov, 6th. Novyye issledovaniya titanovykh splavov (New research on titanium alloys); trudy soveshchaniya. Moscow, Izd-vo Nauka, 1965, 82-88

TOPIC TAGS: annealing, phase composition, alloy, titanium, titanium alloy, electron microscopy/ VT3-1 alloy, VT14 alloy, VT16 alloy, VT15 alloy, VT10 alloy

ABSTRACT: The structural transformations induced by annealing in (α + β) alloys of the types VT3-1, VT14, and VT16, in β alloy of VT15 and in α alloy of VT10, containing an intermetalloidal strengthening agent, were studied. The study was carried out by means of electron microscopy. Electron microscope photographs of specimens annealed at different temperatures are presented. Annealing alloys under different conditions leads to a phase transformation in the alloys. The optimum phase composition that possesses maximum strength and plasticity was found to consist of single α-phase regions and highly dispersed heterogeneous (α + β) phase regions resulting from the decomposition of the metastable β-phase. Thermal stability of alloys may be increased by the addition of aluminum to the alloy. Orig. art. has: 2 figures.

Card 1/1 mlp SUB CODE: 11/ SUBM DATE: 02Dec65

L 38909-66 EWT(m)/T/EWP(t)/ETI/EWP(k) IJP(c) JD/HW

ACC NR: AP6019769 SOURCE CODE: UR/0370/66/000/003/0125/0129

AUTHOR: Kishkin, S. T. (Moscow); Glazunov, S. G. (Moscow); Khorev, A. I. (Moscow); Rubin, Yu. L. (Moscow); Shilina, E. M. (Moscow)

ORG: none

TITLE: The use of high-temperature thermomechanical treatment in the manufacture of extruded BT-15 titanium alloy tubes

SOURCE: AN SSSR. Izvestiya. Metally, no. 3, 1966, 125-129

TOPIC TAGS: titanium alloy, alloy tube, tube heat treatment, thermomechanical treatment, high temperature treatment, aluminum containing alloy, chromium containing alloy/VT15 alloy

ABSTRACT: Vacuum-arc melted ingots of VT15 titanium-base alloy (2.99—3.05% Al, 10.7—11.1% Cr) were conditioned by machining and extruded into bars 187 mm in diameter. The bars were cut into tube billets which were pierced, conditioned and extruded at 950—1150C into tubes with an outside diameter of 110 mm and a wall thickness of 10 mm. Part of the extruded tubes were air cooled and then subjected to conventional heat treatment (annealing at 800C followed by water quenching); another part was subjected to high temperature thermomechanical treatment (HTMT), i.e., were water quenched immediately after extrusion. Both tube lots were then

Card 1/1 UDC: 669.295.5-157.9