PHASE I BOOK EXPLOITATION SOV/4654

Savitskiy, Yevgeniy Mikhaylovich, Professor, Doctor of Chemical Sciences

Redkiye metally i splavy (Rare Metals and Alloys) Moscow, Dom tekhniki, 1959. 83 p. No. of copies printed not given.

General Ed.: I.I. Novikov, Candidate of Technical Sciences, Ed.: V.V. Pereverzev; Tech. Ed.: V.I. Zykin.

PURPOSE: This book is intended for workers of scientific research institutes, design bureaus, and various plants.

COVERAGE: The book presents the latest information on the structure, use, and properties of rare metals and metal alloys containing rare elements. The first and fourth parts of the book review the principal physicochemical properties of rare elements and present data from published works concerning the industrial use of these elements mainly in various constructions and instruments. The second and third parts of the work discuss the results of efforts of the author and his coworkers to determine certain properties of rare metals and their alloys and to construct equilibrium diagrams for systems containing rare elements. V.V. Baron, V.F. Terekhova, and M.A. Tyl-

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kina, Candidates of Technical Sciences, directed laboratory experiments conducted in the Institut Metallurgii Akademii Nauk SSSR [Institute of Metallurgy, Academy of Sciences USSR]. There are 21 references: 16 Soviet and 5 translations into Russian)

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SAVITSKIY, Ye.M.

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18(4,7);25(1) PHASE I BOOK EXPLOITATION SOV/2568

Akademiya nauk SSSR. Institut nauchno-tekhnicheskoy informatsii

Metallurgiya i metallovedeniye; khimiya, metallovedeniye i obrabotka titana (Metallurgy and Metallography; Chemistry, Metallography, and Treatment of Titanium) Moscow, Izd-vo AN SSSR, 1959. 383 p. (Series: Itogi nauki; tekhnicheskiye nauki, 2) Errata slip inserted. 2,700 copies printed.

Ed.: N. V. Ageyev, Corresponding Member, Academy of Sciences, USSR; Ed. of Publishing House: V. S. Rzheznikov; Tech. Ed.: Yu. V. Rylina.

PURPOSE: This collection of articles is intended for metallurgists working with titanium and titanium alloys.

COVERAGE: The articles in this collection deal with the chemistry, metallurgy, and machining of titanium and titanium alloys. The articles are based on abstracts appearing in the Referativnyy zhurnaly for chemistry and metallurgy, from 1953 to 1955. For the most part the articles are based on non-Soviet material. No personalities are mentioned. References follow each article.

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TABLE OF CONTENTS:

This is a review of studies in the crystallography of metallic titanium and a number of its compounds. Intermetallic compounds covered are those of titanium with metals of Groups I, III, V, VI, and VII. Data on compounds of titanium with nonmetals and metalloids of Groups III, IV, V, VI, and VII are also presented.

Binary and ternary titanium-base systems are studied. It is shown that in binary systems, the nature of the chemical reaction between titanium and the given element is determined by the position of that element in the periodic table. Formation or nonformation of a solid solution is dependent on the degree of similarity between the two elements. Data on the solubility of various chemical elements in titanium are given in a number of tables arranged according to chemical groups. A set of 18 constitution diagrams of ternary titanium-alloy systems is included. It is stated that these diagrams represent virtually all known data on these systems published up to 1955.

Savitskiy, Ye. M., and M. A. Tylkina. Properties of Titanium and Titanium Alloys 103

This is a survey of the physical and mechanical properties of titanium and titanium alloys. Data are given on the effect of oxygen, nitrogen, hydrogen, and carbon on the mechanical properties of titanium.

Gudtsov, N. T., and L. D. Mashtakova. Heat Treatment of Titanium and Titanium Alloys 163

The authors discuss work hardening, annealing, grain refining, and other heat-treating methods for titanium and titanium alloys. Also discussed are the effect of alloying elements on heat-treating characteristics, mechanical properties after heat treating, and structural changes at heat treating.

Arzhanyy, P. M. Thermochemical Treatment /Diffusion Coating/ of Titanium 187

This article deals with the nitriding, boronizing, and siliconizing of titanium.

Shelest, A. Ye., A. N. Danil'chenko, and I. M. Pavlov. Forming of Titanium and Titanium Alloys 195

The authors discuss the special features of plastic deformation, general characteristics of cold and hot working, individual forming operations, preparatory and finishing operations, organization of production, and storage and utilization of waste.

Savitskiy, Ye. M., and M. A. Tylkina. Recrystallization of Titanium Alloys 226

Recrystallization of magnesium-reduced and iodide titanium is discussed in reference to its occurrence after cold working, hot forging, annealing, tempering, and hardening. Data are also

SAVITSKIY, Ye. M.

18(7) PHASE I BOOK EXPLOITATION SOV/3355

Akademiya nauk SSSR. Institut metallurgii. Nauchnyy sovet po problеme zharoprochnykh splavov

Issledovaniya po zharoprochnym splavam, t. IV (Studies on Heat-resistant Alloys, vol. 4), Moscow, Izd-vo AN SSSR, 1959. 400 p. Errata slip inserted. 2,200 copies printed.

Ed. of Publishing House: V. A. Klimov; Tech. Ed.: A. P. Guseva; Editorial Board: I. P. Bardin, Academician; G. V. Kurdyumov, Academician; N. V. Ageyev; Corresponding Member, USSR Academy of Sciences; I. A. Oding, I. M. Pavlov, and I. P. Zudin, Candidate of Technical Sciences.

PURPOSE: This book is intended for metallurgists concerned with the structural metallurgy of alloys.

COVERAGE: This is a collection of specialized studies of various problems in the structural metallurgy of heat-resistant alloys. Some are concerned with theoretical principles, some with descriptions of new equipment and methods, others with properties of specific materials. Various phenomena occurring under specified conditions are studied and reported on. For details, see Table of Contents. The articles are accompanied by a number of references, both Soviet and non-Soviet.

Studies (Cont.) SOV/3355

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SAVITSKIY, YE. M.

18(4) PHASE I BOOK EXPLOITATION SOV/1896

Akademiya nauk SSSR. Institut metallurgii

Metallurgiya, metallovedeniye, fiziko-khimicheskiye metody issledovaniya (Metallurgy, Study of Metals, and Physicochemical Methods of Investigation) Moscow, Izd-vo AN SSSR, 308 p. (Series: Its: Trudy, vyp. 3) Errata slip inserted. 3,000 copies printed.

Resp. Ed.: I.P. Bardin, Academician; Ed. of Publishing House: A.S. Chernov; Tech. Ed.: I.F. Kuzmin.

PURPOSE: This book is of interest to researchers in metallurgy, as well as to the technical personnel of the metallurgical industry.

COVERAGE: This volume of the Trudy (Transactions) of the Institut metallurgii imeni A.A. Baykova (Metallurgical Institute im. A.A. Baykov) contains 31 studies on metallurgy, individual metals and alloys, and physicochemical methods of investigation. Some of the studies pertain to the reduction of titanomagnetites, the viscosity and other characteristics of blast furnace slag, dislocation in metals, cracking of metals due to corrosion, simultaneous

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solubility of metals at various temperatures, apparatus for measuring electrical resistance and for determining the melting point of alloys and metals, optical spectral analysis, quantitative determinations by the sublimation method, and aging of alloys. Each study is accompanied by references.

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Metallurgy, Study of Metals (Cont.) SOV/1896

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VOL, Abram Yevgen'yevich; AGEYEV, N.V., red.; ABRIKOSOV, N.Kh., doktor tekhn.nauk, red.; KORNILOV, I.I., red.; SAVITSKIY, Ye.M., red.; OSIPOV, K.A., doktor tekhn.nauk, red.; GUSEVA, L.N., kand.khim.nauk, red.; MIRGALOVSKAYA, M.S., kand.khim.nauk, red.; SHKLOVSKAYA, I.Yu., red.; MURASHOVA, N.Ya., tekhn.red.

[Structure and properties of binary metal systems] Stroenie i svoistva dvoinykh metallicheskikh sistem. Pod rukovodstvom N.V.Ageeva. Moskva, Gos.izd-vo fiziko-matem.lit-ry. Vol.1. [Physicochemical properties of elements; nitrogen, actinium, aluminum, americium, barium, beryllium, and boron systems] Fiziko-khimicheskie svoistva elementov; Sistemy azota, aktiniia, aliuminiia, ameritsiia, bariia, berilliia, bora. 1959. 755 p. (MIRA 13:3)

1. Chlen-korrespondent AN SSSR (for Ageyev).
(Metals) (Phase rule and equilibrium)

SAVITSKIY, Ye. M.

"Influence of Temperature on Mechanical Properties of Intermetallic Compounds."

paper presented at the Electrochemical Society Meeting in Philadelphia, 3-7 May 1959

Eval. B-3,131,204

S/137/60/000/009/018/029
A006/A001

Translation from: Referativnyy zhurnal, Metallurgiya, 1960, No. 9, pp. 257-258,
21596

Dr. Chemical Sci.

AUTHORS: Savitskiy, Ye.M., Terekhova, V.F., Tsikalov, V.A.

TITLE: Investigation of the Physico-Chemical Interactions of Rare-Earth Metals With Iron and Steel

PERIODICAL: V sb.: Redkozemel'n. elementy v stalyakh i splavakh, Moscow, Metallurgizdat, 1959, pp. 31-49

TEXT: The authors studied the interaction of rare-earth metals, such as La and Ce, with S, O, Si and C of steel and the effect of Ce and La on the mechanical properties of Fe. The Fe-La system, with up to 2 weight percent La, was studied by microscopical, electronoscopical and mechanical methods. It is established that small additions of rare-earth metals (0.2-0.5%) refine considerably the structure of Fe and steel. Rare-earth metals are strong deoxidizers which cause the fine-dispersed distribution of oxide impurities. The addition of 0.2-0.5% rare-earth metals to steel containing S > 0.1% cause considerable desulfuri-

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S/137/60/000/009/018/029
A006/A001

Investigation of the Physico-Chemical Interactions of Rare-Earth Metals With Iron and Steel

zation. At a S content of $< 0.02-0.03\%$, desulfurization is not observed. The presence of $\leq 0.2\%$ Si in the steel does not reduce the refining effect of Ce. The rare-earth metals introduced into the steel in an amount of 0.9-1.5%, interact with C, forming carbides, and reduce considerably the perlite content in the steel. The addition of 0.1-0.2% rare-earth metals causes higher strength, ductility and a_k of steel. An increase of the rare-earth metal content from 0 to $> 3\%$ reduces the mechanical properties of Fe and steel due to the formation of brittle intermetallic compounds of Fe with the rare-earth metals. At a La content of $> 0.4-0.5$ weight %, a second phase is observed in the Fe-La system. Solubility of La in γ-Fe is greater than in α-Fe. A considerable improvement of physico-mechanical properties of Fe-Al alloys was observed when rare-earth metals were introduced in an amount of up to 5 weight %.

A.R.

Translator's note: This is the full translation of the original Russian abstract.

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SOV/136-59-1-12/24

AUTHORS: Savitskiy, Ye.M., and Terekhova, V.F.

TITLE: Yttrium and its Alloys (Ittriy i yego splavy)

PERIODICAL: Tsvetnyye Metally, 1959, Nr 1, pp 48-53 (USSR)

ABSTRACT: The authors have carried out an investigation of the microstructure and properties of yttrium and its alloys and the reaction and influence of the element on alloy properties. Yttrium for the investigation was supplied by D.D. Sokolov, L.A.Izhvanov and N.P.Vershinin. The purity of the metal was 96.5%, its microstructure characterised by inclusions of a second phase both at grain boundaries and within grains (Fig 1). The Brinel hardness was 80-85 kg/mm^2 and the ultimate strengths in tension and compression were 16 and 82 kg/mm^2. It was found that yttrium is completely dissolved by cerium; with aluminium, iron and copper eutectic mixtures are found; in alloys with chromium, titanium and zirconium, yttrium does not dissolve in large quantities, with peritectoid reactions over small concentration ranges and immiscibility in the solid state at higher yttrium contents; yttrium is practically immiscible with vanadium, niobium, tantalum and molybdenum. The

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SOV/136-59-1-12/24

Yttrium and its Alloys

introduction of 0.1 - 0.2% yttrium refines the grains of almost all the cast metals studied, but with aluminium and magnesium the opposite effect is produced. Yttrium has a deoxidizing and inoculating effect on all the alloys and with magnesium and aluminium the element has a hardening effect. The authors recommend that the study of the alloying action of yttrium should be made the subject of special investigations.

Figs 3,4,6 and 7 show microstructures of alloys of yttrium with aluminium, chromium, copper and zirconium, respectively, Fig 2 shows the macro- (left) and micro-structures (centre and right) for a 10-% Y magnesium alloy and Fig. 5 the microstructures of 10-% Y alloys with molybdenum (left), tantalum (centre) and vanadium

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Yttrium and its Alloys

(right).
There are 7 figures and 8 references, 6 of which are Soviet and 2 English.

ASSOCIATION: Institut Metallurgii AN SSSR (Institute of Metallurgy, AS USSR).

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SAVITSKIY, Ye.M.; TYLKINA, M.A.

Properties of titanium and its alloys. Itogi nauki: Tekh. nauki no.2:103-162 '59. (MIRA 12:9)

(Titanium)

SAVITSKIY, Ye.M.; TYLKINA, M.A.

Recrystallization of titanium and its alloys. Itogi nauki: Tekh. nauki no.2:226-246 '59. (MIRA 12:9)
(Titanium--Metallography) (Crystallization)

SOV/129-59-3-9/16

AUTHORS: Savitskiy, Ye.M., Terekhova, V.F. and Burov, I.V.

TITLE: Influence of Rare Metals on the Mechanical Properties of Iron-aluminium Alloys (Vliyaniye redkikh metallov na mekhanicheskiye svoystva zhelezoalyuminiyevykh splavov)

PERIODICAL: Metallovedeniye i Termicheskaya Obrabotka Metallov, 1959, Nr 3, pp 38 - 43 + 2 plates (USSR)

ABSTRACT: Up to relatively recently, it was not possible to produce Fe-Al alloys with aluminium content of about 16 wt.% with an elongation at room temperature exceeding 3%. The cause of such brittleness was obviously the large quantity of non-metallic Al_2O_3 inclusions, the presence of a considerable quantity of admixtures in the original iron and also the formation of chemical compounds and of superstructures. The increased brittleness is also brought about by the tendency of these alloys to form a large number of micro-cracks due to low-temperature conductivity and also due to the tendency to grain growth. The authors investigated the effects of applying rare metals for improving the

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Influence of Rare Metals on the Mechanical Properties of Iron-aluminium Alloys

mechanical properties of alloys of this type. The alloys were produced using as starting materials electrolytic iron of 99.58% purity and aluminium of 99.99% purity. The influence was investigated of alloying additions of the following elements: Zr, Ti, Ta, Nb, V, B, Mo, Ce. The additions were selected for the purpose of determining their influence as deoxidation agents, inoculation substances and carbide-forming substances. The chemical composition of the investigated 38 alloys is entered in Table 1, p 40. The effect of the individual elements on the mechanical properties was investigated and also on the magnetic and the technological properties. In Figure 6, the dependence of the hardness on additions of rare metals is graphed for iron-aluminium alloys containing 15-16% Al. In Figure 7, the influence of cerium on the macro- and microhardness of iron-aluminium alloys is graphed. In Figure 8, the influence of additions of rare metals on the strength of iron-aluminium alloys is graphed. Figures 2-5 show microphotos

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Influence of Rare Metals on the Mechanical Properties of Iron-aluminium alloys

(magnification 100 times) of Fe-Al alloys containing various additions and also non-metallic inclusions. In Figure 9, the influence of zirconium and tantalum on the ductility of Fe-Al alloys during hot rolling is graphed. Numerical data on the influence of zirconium and tantalum on the impact strength of alloys are entered in Table 2; numerical data on the influence of Ta, Zr and Ce on the tensile strength of Fe-Al alloys are entered in Table 3. The authors arrived at the following conclusions. 1)The main harmful admixture which causes brittleness of Fe-Al alloys is oxygen, which forms occlusions of aluminium oxides along the boundaries and in the body of the grains. A good method of producing alloys with a minimum content of oxygen is induction smelting, in a pure helium atmosphere, in crucibles made of aluminium oxide and introducing aluminium on the surface of the metal. It is necessary to deoxidise primarily the iron in vacuum with carbon or hydrogen.. 2) An appreciable refining of the grain of Fe-Al alloys

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Influence of Rare Metals on the Mechanical Properties of Iron-aluminium Alloys

occurs as a result of additions of Ti and combined additions of cerium with zirconium, cerium with molybdenum and cerium with vanadium.

3) Boron and vanadium in quantities up to 0.05 - 0.2% increases appreciably the hardness of the alloys. The strength of the alloys increases from 22 - 37 kg/mm^2 as a result of addition of 0.05% boron; tantalum (0.2%) and zirconium (0.5%) increases the strength by 20 - 25 kg/mm^2 and also the impact strength and the ductility during hot rolling.

4) Magnetic Fe-Al alloys can be easily deformed in the hot state and rolled into sheet. Non-magnetic alloys (based on FeAl compounds) can be rolled only if the optimum rolling regimes are equally complied with (a well-treated surface, small values of reduction, low speeds of deformation and strict adherence to the specified temperature conditions).

5) Combined alloying with cerium (0.25%), vanadium (0.25%)

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Influence of Rare Metals on the Mechanical Properties of Iron-aluminium Alloys

and molybdenum (1.8%) brings about a shift in the line of the magnetic transformation of the iron-aluminium alloys (from 16 to 14% Al content).

6) None of the investigated alloys oxidises in air at 1 200 °C and all have a corrosion resistance commensurate with that of refractory steels. The specific gravity of such Fe-Al alloys (containing 16% Al) is 20% lower than the specific gravity of steel.

7) Iron-aluminium alloys alloyed with small quantities of cerium, zirconium, tantalum, etc. can be applied as relatively cheap high-strength materials at room and at elevated temperatures and also as materials with a high resistance to corrosion. There are 9 figures, 3 tables and 15 references, 5 of which are Soviet, 1 Japanese, 1 German and 8 English.

ASSOCIATION: Institut metallurgii AN SSSR (Institute of Metallurgy of the Ac.Sc.USSR)

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SOV/180-59-3-17/43

AUTHORS: Savitskiy, Ye.M., Tylkina, M.A. and Shishkina, L.L. (Moscow)

TITLE: The Phase Diagram of the Tungsten-Rhenium System and Properties of its Alloys

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1959, Nr 3, pp 99-107(USSR)

ABSTRACT: Microstructural and X-ray investigations were used as a basis for constructing the phase diagram. Melting points, hardness and microhardness of the various constituents were measured. The resulting phase diagram is given in Fig 1. Microstructures are shown in Fig 2 and 3 and X-ray photographs in Fig 4. There is a solid solution (α) up to 45% Re near the alloy melting point, falling to 32% at 1100°C. In this region hardness increases with increasing Re content to 420 kg/mm2 at 25% Re. A peritectic reaction takes place at 2890°C. Liquid $+\alpha \rightleftarrows \sigma$. The σ phase has a complex tetragnal lattice with a = 9.53A, c = 4.95A and c/a = 0.52. This phase extends from 40 to 66 wt % Re at 1100°C and from 45 to 66% at 2000°C. It is very brittle and has a hardness of 2000 kg/mm2. The solid solution of tungsten in rhenium extends to 15% W near the melting point and

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The Phase Diagram of the Tungsten-Rhenium System and Properties of its Alloys

12% at 1100°C. There is a eutectic between the σ phase and the β solid solution at 75% Re and 2815°C. The microhardness of the eutectic is 800 kg/mm^2. The two phase region (β + σ) is very narrow. There is a peritectoid reaction as follows: $\sigma + \beta \rightleftarrows X$. The X phase has parameter a = 9.57A and is of the α-Mn type. Its microhardness is 1500 kg/mm^2. Alloys with up to 20% Re have high electrical resistance, strength and plasticity. Fig 1 shows the influence of temperature on properties and Fig 5 the influence of Re on strength. W-Re alloys could be used in the electrical industry. Fig 6 shows the external appearance of electrical contacts after corrosion in moisture. Re after 50 days (a) is in much better condition than W after 30 days and (b) W-Re alloys could also be used in industry where high mechanical properties and close tolerances are required. There are 6 figures, 1 table and 11 references, 3 of which are

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The Phase Diagram of the Tungsten-Rhenium System and Properties of its Alloys

English, 1 German, 1 Polish and 6 Soviet.

SUBMITTED: February 7, 1959

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SAVITSKIY, Ye.M.; TYLKINA, M.A.

Recrystallization of high-melting point titanium, hafnium, tantalum, rhenium, tungsten metals and their alloys. Issl.po zharopr.splav. 4:218-225 '59. (MIRA 13:5)
(Nonferrous metals--Thermal properties)
(Crystallization)

SOV/78-4-2-27/40

18(6)

AUTHORS: Savitskiy, Ye. M., Tylkina, M. A., Povarova, K. B.

TITLE: The Phase Diagram of the System Rhenium-Molybdenum (Diagramma sostoyaniya sistemy reniy-molibden)

PERIODICAL: Zhurnal neorganicheskoy khimii, 1959, Vol 4, Nr 2, pp 424-434 (USSR)

ABSTRACT: The phase diagram of the system Mo-Re was drawn on the basis of the results obtained by physico-chemical and analytical investigations (determination of the melting point, microscopic, X-ray, and phase analyses, determinations of the specific electric resistance, and determination of solidity). For the production of the alloys maximum purity rhenium (99.8%) and molybdenum (99.8%) were used as initial materials. The pressed samples were sintered in vacuum at 1500°. In the system rhenium-molybdenum solid solutions containing 58 weight% rhenium (42 at % Re) are formed at temperatures near the melting point. The solidity of molybdenum alloys increases, in the field of solid solutions, from 130 kg/mm^2 (pure molybdenum) to 205 kg/mm^2 for the alloy containing 53 weight% rhenium. In alloys with 43-46 weight % rhenium the liquidus and solidus curve of the solid solutions show a minimum at a

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The Phase Diagram of the System Rhenium-Molybdenum

temperature from 2450±30°. The X-ray analysis showed that upon increase of rhenium content the lattice constant in the solid solution is reduced and is 3.12 Å in the alloy with 53 weight %. The determination of the electric resistance confirmed the range of solid solutions. The specific electric resistance of pure molybdenum is $6.6.10^{-6}$ ohm·cm, and rises to $27.6.10^{-6}$ ohm·cm in alloys with 42 weight % rhenium. In the system Mo-Re the σ-phase (Re_3Mo_2) is formed after a peritectic reaction at 2570°. The lattice parameters of the σ-phase are: a = 9.54 Å and c = 4.95 Å. The micro-solidity of the σ-phase is 1850 kg/mm^2. The specific electric resistance of the σ-phase is stronger than that of the solid solution and amounts to $3.1.10^{-4}$ ohm·cm in the alloy with 78 weight % Re. The di-phase field α + σ exists between the σ-phase and the field of solid solutions. The mono-phase field of solid solutions of molybdenum in rhenium exists at the melting point temperature starting with 10 weight % molybdenum and amounts up to 2-3 weight % Mo at 1100°. The solidity of the alloy with

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The Phase Diagram of the System Rhenium-Molybdenum

95 weight % Re is reduced to 320 kg/mm^2, and to 290 kg/mm^2 in pure rhenium. In these alloys also the electric resistance is reduced to $57 \cdot 10^{-6}$ ohm.cm for the alloy with 95 weight % Re. In the system Mo-Re the phase χ is formed after the peritectic reaction at 1850°C. The peritectic change $\sigma + \beta \rightleftarrows \chi$ takes place in alloys which contain 81-95 weight % rhenium. The χ-phase has the structure of type α-Mn as has been found by X-ray analysis. The microscopic examinations of solidity and electric resistance of alloys with 81-95 weight % rhenium prove the existence of the χ-phase. The solidity and electric resistance of the alloys are increased by the formation of the new phase χ. There are 7 figures, 2 tables, and 11 references, 3 of which are Soviet.

ASSOCIATION: Institut metallurgii im. A. A. Baykova Akademii nauk SSSR (Institute of Metallurgy imeni A. A. Baykov of the Academy of Sciences, USSR)

SUBMITTED: November 25, 1957

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SOV/78-4-2-28/40

18(6)

AUTHORS: Savitskiy, Ye. M., Terekhova, V. F., Kholopov, A. V.

TITLE: The Phase Diagram of the Alloys of the System Chromium-Cerium (Diagramma sostoyaniya splavov sistemy khrom-tseriy)

PERIODICAL: Zhurnal neorganicheskoy khimii, 1959, Vol 4, Nr 2, pp 435-438 (USSR)

ABSTRACT: The phase diagram of the alloys chromium-cerium (up to 30 weight % cerium) was investigated by micro-structure analyses, thermal analyses, and X-ray analyses. Electrolytic chromium (99.5%) and metallic cerium (99%) were used as initial materials. In the system chromium-cerium separation into two layers takes place in a wide range (10 to 90% cerium) upon liquid state at 1780°. The analyses of the micro-structure of the alloys show that in the field of the solid solution the solidity of the alloy rises upon increase of cerium content. Cerium additions amounting from 1-1.5% to chromium increase the solidity of chromium and refine its structure. Alloys of the system chromium-cerium with cerium contents $>3\%$ are unstable in air and decompose while cerium oxides are formed. The liquidus and solidus curves of these alloys

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The Phase Diagram of the Alloys of the System Chromium-Cerium

were determined. D. Ya. Svet and V. V. Grishin participated in these determinations. The solubility of cerium in solid chromium was determined and it was found that the solubility is 2-3% at 1500°, 3-5% at 1600°, and 5-10% at 1700°. The solubility curve of cerium in solid chromium, depending on the temperature, was drawn on the basis of the micro-structure analysis. The phase diagram of the alloys chromium-cerium (up to 30% cerium) was drawn according to data on micro-structure and thermal analyses. There are 8 figures, 2 tables, and 7 references, 4 of which are Soviet.

ASSOCIATION: Institut metallurgii im. A. A. Baykova Akademii nauk SSSR (Institute of Metallurgy imeni A. A. Baykov of the Academy of Sciences, USSR)

SUBMITTED: November 29, 1957

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18(6),18(7) SOV/78-4-3-34/34

AUTHORS: Savitskiy, Ye. M., Tylkina, M. A., Zot'yev, Yu. A.

TITLE: The Phase Diagram Rhenium - Titanium (Diagramma sostoyaniya sistemy reniy-titan)

PERIODICAL: Zhurnal neorganicheskoy khimii, 1959, Vol 4, Nr 3, pp 702-704 (USSR)

ABSTRACT: The system rhenium - titanium was investigated by the method of metallographical analysis and X-ray analysis. Melting point, electric resistance and hardness of the alloys were determined. As initial materials titanium and rhenium with a purity of 99.8% were used. On the basis of investigations an orientation phase diagram of the system was plotted. In the system solid solutions of rhenium occur in β titanium which spread up to 80 wt% rhenium. At 95 wt%rhenium(82.5 atom%) the chemical compound $Re_{24}Ti_5$ is formed. This compound is brittle and the hardness amounts to 1800-2000 kg/mm^2. The solubility of titanium in rhenium amounts to several %. By means of microscopic and X-ray analysis and the dilatometric investigation of the alloys rich in titanium the limit of the phase ranges α, $\alpha+\beta$ and β

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The Phase Diagram Rhenium - Titanium

was fixed. The solubility of rhenium in α titanium amounts at 725° to 0.1% and rises inconsiderably with rising temperature . In alloys with 10-15% rhenium the ω phase occurs, which was also confirmed by X-ray analysis. The determinations of the electric resistance of the alloys hardened at various temperatures show that with an increase of the rhenium content also the electric resistance increases. The electric resistance in alloys hardened at 700° with 23.7% Re amounts to 131 μ ohm·cm and in the case of alloys with purest titanium to 44.5 μ ohm·cm. Alloys with 46% rhenium show no noticeable increase in the electric resistance. The alloys hardened at 900° have a higher electric resistance than those hardened at 700°. There are 2 figures and 3 references, 2 of which are Soviet.

ASSOCIATION: Institut metallurgii im. A. A. Baykova Akademii nauk SSSR (Institute of Metallurgy imeni A. A. Baykov of the Academy of Sciences, USSR)

SUBMITTED: April 2, 1958

USCOMM-DC-60,727

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SOV/78-4-6-43/44

18(6)

AUTHORS: Savitskiy, Ye. M., Terekhova, V. F., Tsikalov, V. A.

TITLE: The Phase Diagram of the Alloys Aluminum-Yttrium (Diagramma sostoyaniya splavov alyuminiya s ittriyem)

PERIODICAL: Zhurnal neorganicheskoy khimii, 1959, Vol 4, Nr 6, pp 1461 - 1462 (USSR)

ABSTRACT: The system aluminum-yttrium was investigated for the first time. Alloys up to 60 percentages by weight yttrium were produced and investigated by metallographic, thermal, and X-ray structural analyses and the microhardness was determined. Aluminum of the type AV-000 and metallic yttrium of a purity of 99.6% were used as initial materials. The phase diagram of the alloys aluminum-yttrium (60 percentages by weight yttrium) is a complicated system with occurrence of chemical compounds (Fig 1). Chemical compounds occur as crystals in alloys with 13.5 and 42 percentages by weight yttrium. The microstructure of the alloys aluminum-yttrium with 0.34, 8.78. 42.1 and 57.3 percentages by weight yttrium is given in figure 2. Alloys with 57.3 percentages by weight yttrium

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have a composition which corresponds to the formula Al_5Y_2. The microhardness of this alloy amounts to 600 kg/mm^2. By the X-ray structural analysis it was found that this compound has a complicated crystal structure. Further investigations are necessary for the completion of the phase diagram aluminum-yttrium. There are 2 figures.

SUBMITTED: January 30, 1959

SOV/78-4-6-44/44

18(6)

AUTHORS: Savitskiy, Ye. M., Terekhova, V. F., Burov, I. V.

TITLE: Investigations of the Alloys of Niobium With Lanthanum and Cerium (Issledovaniye splavov niobiya s lantanom i tseriyem)

PERIODICAL: Zhurnal neorganicheskoy khimii, 1959, Vol 4, Nr 6, pp 1462 - 1463 (USSR)

ABSTRACT: Thermal-, microstructure-, and X-ray analyses were carried out in the alloys of niobium with lanthanum and the hardness and the electric resistance were determined. On the strength of the investigations phase diagrams of the systems niobium-cerium and niobium-lanthanum (up to 50 percentages by weight cerium and lanthanum) were constructed and given in figures 1 and 2. Niobium of a purity of 99%, metallic lanthanum of 99%, and cerium of a purity of 98.9% were used as initial materials. It was found that niobium with lanthanum and cerium has in the liquid and solid phase wider immiscible regions. The formation of layers in the system niobium-cerium begins already in the case of 1 - 2% cerium and in the alloys niobium-lanthanum in the case of 0.1 - 0.2% lanthanum. The solubility of cerium

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Investigations of the Alloys of Niobium With Lanthanum and Cerium SOV/78-4-6-44/44

and lanthanum in niobium in solid state is not higher than 0.05%. It was found that the plasticity of niobium is increased by the addition of 0.3 - 0.5% cerium. There are 2 figures.

SUBMITTED: January 30, 1959

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SOV/78-4-8-37/43

5(2)

AUTHORS: Savitskiy, Ye. M., Tylkina, M. A., Povarova, K. B.

TITLE: The Phase Diagram of the System Chromium - Rhenium (Diagramma sostoyaniya sistemy khrom - reniy)

PERIODICAL: Zhurnal neorganicheskoy khimii, 1959, Vol 4, Nr 8, pp 1928-1930 (USSR)

ABSTRACT: By means of various physico-chemical methods (determination of the melting point, microscopic analysis, X-ray analysis, measurements of hardness and microhardness), the phase diagram chromium-rhenium was determined (Fig. 1). Some microstructures of cast or thermally processed alloys are shown in figure 2. The phase diagram shows a peritectic type. The peritectics are between 2350° (liquid phase + $\beta \rightleftarrows \sigma$) and 2280° (liquid phase + $\sigma \rightleftarrows \alpha$ (the solid α-solution is formed on Cr-basis, the solid solution on Rh-basis)). The hardness of the solid solution increases with the rhenium content (138 kg/mm^2 for pure Cr, 322 kg/mm^2 for the alloy with 63.5 % by weight Rh). The one-phase range of the solid solution of chromium and rhenium was approximately outlined. Apparently the solubility of chromium

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SOV/78-4-8-37/43

The Phase Diagram of the System Chromium - Rhenium

in rhenium does not exceed 5 % by weight Cr. It is emphasized that an addition of 40% rhenium to chromium improves the plasticity of chromium and its processing is facilitated by cutting. There are 2 figures and 8 references, 4 of which are Soviet.

SUBMITTED: March 17, 1959

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SOV/78-4-1o-23/4o

5(2)

AUTHORS: Tylkina, M. A., Pekarev, A. I., Savitskiy, Ye. M.

TITLE: Phase Diagram of the System Titanium - Hafnium

PERIODICAL: Zhurnal neorganicheskoy khimii, 1959, Vol 4, Nr 1o, pp 232o - 2322 (USSR)

ABSTRACT: According to data obtained by means of different methods the phase diagram Ti - Hf was constructed (Fig 1a). As it was to be expected according to the analogous structure of the electron shell of these elements, they form a continuous series of solid α- and β-solutions which are separated by a diphase α+β-region. The curves of the changes of physical properties of the melts with variable composition (Fig 1b) confirm this phase diagram. Figure 2 shows the microstructure of titanium - hafnium alloys treated in a different way. There are 2 figures and 6 references, 3 of which are Soviet.

ASSOCIATION: Institut metallurgii im. A. A. Baykova Akademii nauk SSSR (Institute of Metallurgy imeni A. A. Baykov of the Academy of Sciences, USSR)

SUBMITTED: May 4, 1959

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SOV/180-59-5-25/37

18.1200

AUTHORS: Agafonova, M.I., Baron, V.V., and Savitskiy, Ye.M. (Moscow)

TITLE: Structure and Properties of Niobium-Tin Alloys

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1959, Nr 5, pp 138-141 (USSR) (+ 1 plate)

ABSTRACT: Metallo-ceramic niobium of the following composition (wt %) was used as the starting material: Nb 98.1, Ta 1.2, Ti 0.15, Fe 0.085, N 0.2, C 0.03, O 0.2, Si 0.04 and Pb 5.10^{-3}, and 0-1 tin (99.9% Sn). The alloys were prepared in an arc furnace on a water-cooled copper hearth, using insoluble tungsten electrodes, in an atmosphere of chemically pure argon (0.6 atm pressure). As the boiling point of tin is lower than the melting point of niobium (2280° as against 2415 °C), considerable evaporation of tin occurred on melting. Therefore, 50% more tin was added to the charge than the calculated amount. The arc melting method enables niobium alloys with any tin content to be prepared. The authors have prepared ingots of 22 alloys, weighing up to 40 g. The composition of the alloys is shown in Table 1. In order to ensure a uniform composition the alloys were remelted

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Structure and Properties of Niobium-Tin Alloys

several times. Alloys containing up to 30% tin were annealed in evacuated quartz double ampoules in a Silit furnace at 1100 °C for 50 hours. Alloys richer in tin, in view of their lower melting point, were annealed at 200 °C for 100 hours. One part of the alloys (containing 85-100% Sn) were deformed by approximately 60% by cold forging, prior to annealing. The limit of solubility of tin in niobium was determined by quenching and testing the microhardness. Water quenching of the alloys was carried out in evacuated quartz double ampoules from the following temperatures: 800 °C, (after soaking for 100 hours) and 1100 °C (after soaking for 50 hours). Quenching from 1400 and 2000 °C (after soaking for 20 minutes) was carried out in an apparatus for measuring melting temperatures, quenching from 1800 °C was carried out in the vacuum furnace TVV (after soaking for 3 hours). Sections for microscopic analysis were prepared by the usual method. Alloys containing up to 35% Sn were etched in a mixture of HNO_3 and HF (concd) and those containing between 35 and 100% Sn, in a 30% aqueous solution of HCl. The microhardness of the

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Structure and Properties of Niobium-Tin Alloys

alloys was tested with a PMT-2 instrument, using a load of 20 g. The hardness of the alloys was tested in a Vickers hardness testing machine at a load of 5 kg. X-ray investigations of annealed alloys were carried out in a Debye camera with a Cu-irradiation. The melting temperature of the more refractory niobium-tin alloys was determined by the drop method, using an optical pyrometer. The temperature was measured at which the first drop appeared in the drilled-out centre bore of a specimen; the ratio between the depth and the diameter of the bore was approximately 4; this ensured practically absolutely black body conditions. The thermal analysis of less refractory alloys (between 30 and 100% Sn) was carried out with a Kurnakov pyrometer which uses differential registration, in sealed quartz ampoules. In this case the highest measured temperature did not exceed 1000 °C. The determination of the rate of oxidation of the alloys was carried out on specimens of rectangular shape by measuring the gain in weight. The surface of the specimen was first ground on a fine emery paper. Then the specimens were placed in annealed

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Structure and Properties of Niobium-Tin Alloys

beryllium oxide crucibles and held there for one hour in air. On the basis of the results obtained, which are shown in Table 2, the thermal equilibrium diagram of the Nb-Sn system was constructed (Fig 1). Experimental results obtained in the investigation of the microstructure and measurements of the microhardness of the alloys are shown in Figs 2 and 3 respectively. It has been found radiographically that the parameter changes in the solid solution range are negligible, as the atomic radii of the two elements are very similar. Alloys containing more than 9.5% tin exhibit a second phase along the grain boundaries at room temperature (Fig 2g), consisting of the compound Nb_3Sn, which forms at 2000 °C in the peritectic reaction. This compound has a complex cubic structure of the β-W type with a lattice parameter of a = 5.29 Å, is very brittle and has a great microhardness (H μ = 900 kg/mm^2). A further increase in tin content leads to the appearance of a soft (H μ = 10 kg/mm^2), low melting-point tin-rich phase which melts at 232 °C, and subsequently to a separation of the alloy into the molten and solid states (Fig 2e, zh, and z) (see Table 2).

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Structure and Properties of Niobium-Tin Alloys

No intermediate phases have been observed in the system by microscopic and X-ray analyses. The solubility of niobium in tin at the melting point of tin is less than 0.1%. The hardness of alloys in the region of niobium-base solid solutions increases from 150 kg/mm^2 (for niobium) to 300 kg/mm^2 (at a maximum tin content). In the 2-phased region the hardness continues to increase additively until the Nb_3Sn_4 compound is formed, the hardness of which is 900 kg/mm^2 (Fig 4). The hardness of tin-rich alloys is close to that of tin (9 kg/mm^2) and hardly increases with increase in tin content of up to 20% due to the presence of a soft tin-rich phase. In Fig 5 the results of the measurement of the rate of oxidation of Nb-Sn alloys in the concentration range of 0-20% Sn on holding in air at 800 and 1000 °C for one hour, are shown. The results shown in Figs 4 and 5 show that the alloys in the solid solution range of tin in niobium have a greater hardness and resistance to oxidation than pure niobium.

There are 5 figures, 2 tables and 6 references, of which 1 is Soviet, 1 is German and 4 are English.

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SOV/89-7-3-5/29

18(6), 21(1)

AUTHORS: Savitskiy, Ye. M., Tylkina, M. A., Tsyganova, I. A.

TITLE: The Phase Diagram of the System Zirconium - Rhenium

PERIODICAL: Atomnaya energiya, 1959, Vol 7, Nr 3, pp 231-235 (USSR)

ABSTRACT: By means of the well-known radiographical and microscopical methods the melting point, the hardness, and the microhardness of the phases were measured. On the basis of these data the phase diagram of the zirconium - rhenium system was set up. In α-zirconium the range of the solid solution of rhenium amounts to ~0.5 % by weight at 800°C. At the eutectic transformation temperature the percentage increases to 2-3 % by weight. In β-zirconium at 1600°C 14.68 % by weight of rhenium and at the eutectic point of transformation at 500-600°C only 8 % by weight are dissolved. In alloys containing more than 4 % by weight of rhenium, a stable β-phase is found. At 1600°C and 25 % by weight of rhenium a eutectic forms. In alloys with a high zirconium content a metastable ω-phase was found to exist. The solubility of zirconium in rhenium at 2500°C is less than 2 % by weight. Three chemical compounds are produced in the system by peritectic reactions: 1) At 2500°C: Zr_5Re_{24} of the α-Mn-type

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SOV/89-7-3-5/29

The Phase Diagram of the System Zirconium - Rhenium

with volume-centered cubic lattice (a = 9.6 - 9.7 kX). Microhardness amounts to 1000 kg/mm^2. 2) At 2450°C: ZrRe$_2$ with hexagonal tightly bound lattice (a - 5.21 - 5.25 Å; c = 8.5 - 8.56 Å; c/a = 1.63). Microhardness 1200 kg/mm^2. 3) At 1900°C: Zr$_2$Re σ-phase type with tetragonal lattice (a = 10.12 Å; c = 5.42 Å; c/a = 0.535). Microhardness 700 - 800 kg/mm^2. The phase diagram and microhardness are shown graphically. Photographs are available for some of the ground sections. The radiographic investigations were carried out by P. I. Kripyakevich and Ye. I. Gladyshevskiy at the LGU. There are 7 figures, 1 table, and 8 references, 4 of which are Soviet.

SUBMITTED: April 16, 1959

Card 2/2

5(2,4) SOV/20-125-1-22/67

AUTHORS: Kopetskiy, Ch. V., Shekhtman, V. Sh., Savitskiy, Ye. M. Ageyev, N. V., Corresponding Member, AS USSR,

TITLE: Formation of the σ Phases in the Rhenium-manganese and Rhenium-iron Systems (Obrazovaniye σ-faz v sistemakh reniy-marganets i reniy-zhelezo)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 125, Nr 1, pp 87-88 (USSR)

ABSTRACT: Among the numerous known binary and ternary systems of transition metals σ phases are observed, i.e. compounds with an isomorphous structure of the β-U type. According to modern opinions the condition for the formation of the σ phase is as follows: if one of the components belongs to group VII or VIII of the periodic system the second component must be of group V A or VI A. However, the ε phase of the iron-rhenium system has also a crystal lattice of the σ phase (Refs 1, 2). Since the latter system does not correspond to the above-mentioned condition the σ phase cannot be explained within the framework of the existing theories (Refs 3, 4). The alloy produced by the authors showed a diffraction pattern confirming the data from reference 1 (Table 1). Lattice temperatures were:

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Formation of the σ Phases in the Rhenium-manganese and Rhenium-iron System SOV/20-125-1-22/67

a = 9.92 Å, c = 4.69 Å and c/a = 0.52. Microhardness = 1234 kg/mm^2. Publications contain no data on the following production of the rhenium-manganese alloy. It may be seen from roentgenographic results that the annealed (for 360 hours in vacuum at 1000°) alloy is homogeneous and has a lattice of the σ phase. Parameter: a = 9.14 Å, c = 4.75 Å, c/a = 0.52 (Table 1). The σ phase forms from enamel (Fig 1). The observation of σ phases in the systems mentioned in the title leads to additional difficulties in the theoretical explanation of the conditions of formation of these compounds of transition metals. If these phases are regarded as a type of electron compounds (Ref 3), it strikes that rhenium similar to manganese shows an anomalous behavior as compared to metals of other groups. There are 1 figure, 1 table, and 4 references, 1 of which is Soviet.

ASSOCIATION: Institut metallurgii im. A. A. Baykova Akademii nauk SSSR (Institute of Metallurgy imeni A. A. Baykov of the Academy of Sciences, USSR)

SUBMITTED: November 17, 1958

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SOV/20-126-4-22/62

18(7)

AUTHORS: Savitskiy, Ye. M., Baron, V. V., Ivanova, K. N.

TITLE: The Diagram of the Recrystallization of Niobium (Diagramma rekristallizatsii niobiya)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 126, Nr 4, pp 771 - 773 (USSR)

ABSTRACT: In the introduction the good mechanical and physical properties of niobium are stressed, and determination of the recrystallization temperature of niobium and the investigation of the influence exercised by 11 alloys upon the beginning of recrystallization are given as the task to be achieved by this paper. Treatment of the bars of 29 mm diameter and 120 mm length, which was carried out for the purpose of eliminating the coarse structure, and by means of which a fine-grain polyhedral structure was obtained, is described. It was found that the plastic properties of niobium improve considerably after annealing, and a recrystallization diagram is shown, from which the dependence of grain sizes on deformation and on the annealing temperature may be seen. Determination of the beginning of recrystallization was carried out by means of X-ray methods. It was found that the temperature of the beginning of recrystallization decreases from 1200° to 1025°C with increasing deformation. De-

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termination of hardness at deformations of up to 80% showed an increase of from 135 kg/mm^2 at 0% to 165 kg/mm^2 at 80%. Further, the dependence of grain sizes on the annealing temperature is discussed and the critical degree of deformation at an annealing temperature of 1300° is given as amounting to 7.5%. In this case a grain size of 251 μ was obtained. From the results obtained the conclusion is drawn that the most favorable thermomechanical treatment of niobium may be carried out within the temperature interval of 1100-1450°C and with a degree of deformation exceeding 10%. There are 3 figures, 1 table, and 7 references, 2 of which are Soviet.

ASSOCIATION: Institut metallurgii im. A. A. Baykova Akademii nauk SSSR (Institute of Metallurgy imeni A. A. Baykov of the Academy of Sciences, USSR)

PRESENTED: February 25, 1959, by P. A. Rebinder, Academician

SUBMITTED: February 14, 1959

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SOV/20-127-2-21/70

24(2)

AUTHORS: Tylkina, M. A., Kirilenko, R. V., Savitskiy, Ye. M.

TITLE: The Diagram of Recrystallization of Hafnium

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 127, Nr 2, pp 310-312 (USSR)

ABSTRACT:

It is the object of the present study to determine some of the properties of hafnium and to investigate recrystallization- and deformation-processes. From metallographic and X-ray analyses, as well as by determining hardness, the authors derived the recrystallization diagram shown in figure 1. Hafnium is a dimorphous metal, the hexagonal α-modification changing into the cubic body-centered β-modification at higher temperatures. Hafnium iodide bars of coarse structure were used as original material. The physical properties of these Hafnium iodide bars are given together with a description of the elimination of the coarse structure. The deformation was carried out in eight steps from ranging 5% to the maximally tolerable deformation of 60%. Vacuum-annealing was performed in seven stages between 750 and 1550° C . Recrystallization set in at 1000° C after 10%

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deformation, at 850° C after 20% deformation, and at 750° C after 40% or more deformation. Annealings within the temperature range of the α-modification yield a fine-grained polyeder structure with grain sizes of between 25 and 40 μ after 30% to 45% deformation. Annealings above the temperature of the polymorphous transition gives a coarser grain (240 μ) and a marked structural change. The similarity of the deformation- and recrystallisation properties between hafnium, titanium and zirconium is pointed out. Also, their α- and β-modifications are compared and their high plasticity stressed. By their hardness and cold workability they are arranged in the following order: titanium - zirconium - hafnium. It follows from the recrystallization diagrams of the

The Diagram of Recrystallization of Hafnium SOV/20-127-2-21/70

three metals that they also have similar grain sizes. Finally, the temperature stability of these metals and their alloys is emphasized. There are 3 figures and 11 references, 6 of which are Soviet.

ASSOCIATION: Institut metallurgii im. A. A. Baykova Akademii nauk SSSR (Institute for Metallurgy imeni A. A. Baykov of the Academy of Sciences, USSR)

PRESENTED: March 26, 1959, by I. P. Bardin, Academician

SUBMITTED: March 25, 1959

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~~5 (2)~~ 18.1200

66456

SOV/20-129-3-24/70

AUTHORS: Ageyev, N. V., Corresponding Member, AS USSR,
Kopetskiy, Ch. V., Savitskiy, Ye. M.,
Shekhtman, V. Sh.

TITLE: On the Interaction of the Elements of the VIIA Subgroup With Transition Metals

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 129, Nr 3, pp 559 - 562 (USSR)

ABSTRACT: Mn is known to be an anomalous metal with regard to combining forces between the atoms, the crystalline structure, etc. (Refs 1,2). Active interaction with the elements of the subgroups IVA, VA, and VIA is typical of rhenium. In connection herewith, σ- and χ-phases are formed in binary systems (Refs 3,4). Mn and Re are analogous with regard to the formation of oxides, acids, etc. It is, however, unknown whether they are analogous with regard to interaction with metals. Table 1 shows distinct differences of the physical properties of Mn, Re, and Tc. Great similarity of Mn and Re as to the formation of metallic phases can be seen in analyzing the interaction of Mn and Re with transition metals. Figure 1 shows the dependence of the value of the dimension factor (razmernyy faktor) P

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On the Interaction of the Elements of the VIIA Subgroup With Transition Metals SOV/20-129-3-24/70

(with regard to Mn and Re) on the group number of the periodic system for all transition metals (Ref 6). Figure 1 shows the compounds formed with a corresponding transition metal in a binary system of Mn or Re. Mn and Re and the above elements of the subgroups IVA and VA form Laves phases with a structure of the type $MgZn_2$ and $MgNi_2$ ($ZrRe_2$, $ZrMn_2$, $TiMn_2$, $TaMn_2$, $NbMn_2$). All these compounds are formed from the liquid phase and are stable up to room temperature. It may be concluded therefrom that there exists great similarity between Mn and Re in the formation of alloys with transition metals. This is proved, above all, by the type of interaction with elements which are at right and at the left of group VII in the periodic system. Compounds are formed with the metals of the subgroups IVA, VA, and VIA. Solid solutions on the basis of more simple structures or compounds with a simple structure, however, are formed with metals of group VIII. In binary systems, Mn and Re form the same type of phases with the metals of the titanium-, vanadium-, and chromium group. Mn and Re show a great tendency towards formation of σ-phases. The structure corresponding to the low-temperature

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On the Interaction of the Elements of the VIIA Subgroup SOV/20-129-3-24/70
With Transition Metals

phase of Mn is formed as an independent compound in systems on Re basis. Since there are no papers available on Tc alloys, the binary systems can not be completely classified on the basis of subgroup VIIA. It may be assumed that Tc reacts in alloys in a similar way as Re. The comparatively distinct classification of the binary systems of transition metals with Mn and Re as well as a restricted set of phases existing in these systems are obviously related to the key position of subgroup VIIA among transition metals. There are 1 figure, 1 table, and 7 references, 3 of which are Soviet.

ASSOCIATION: Institut metallurgii im. A. A. Baykova Akademii nauk SSSR (Institute of Metallurgy imeni A. A. Baykov of the Academy of Sciences, USSR)

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SUBMITTED: August 12, 1959

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KOGAN, B.I., kand. ekon. nauk; SAVITSKIY, Ye.M., doktor khim. nauk, red.; TARAKHOVSKAYA, N.K., otv. red.; SOKOLOVA, N.V., tekhn. red.

[Lithium; fields of established possible application] Litii; oblasti osvoennogo i vozmozhnogo primeneniia. Pod red. E.M.Savitskogo. Moskva, Vses. in-t nauch. i tekhn. informatsii, 1960. 110 p. (MIRA 14:10)

(Lithium)

Savitskiy, Ye. M.

PHASE I BOOK EXPLOITATION SOV/3002

Akademiya nauk SSSR. Institut metallurgii

Issledovaniye splavov tsvetnykh metallov; sbornik 2 (Analysis of Nonferrous Metal Alloys; Collection of Articles, [No.] 2) Moscow, Izd-vo AN SSSR, 1960. 204 p. Errata slip inserted. 2,800 copies printed.

Ed.: I.A. Oding, Corresponding Member, USSR Academy of Sciences; Ed. of Publishing House: V.S. Rzheznikov; Tech. Ed.: T.P. Polenova; Editorial Board: A.A. Bochvar, Academician; M.Ye. Drits, Candidate of Technical Sciences (Deputy Resp. Ed.); N.V. Zakharov, Professor, Doctor of Technical Sciences; B.G. Kadaner, Candidate of Technical Sciences (Resp. Secretary); A.F. Korol'kov, Doctor of Technical Sciences; M.V. Mal'tsev Professor, Doctor of Technical Sciences; and Z.A. Sviderskaya, Candidate of Technical Sciences.

PURPOSE: This collection of articles is intended for workers in scientific research institutes, metal and machine works, for teaching personnel, and for students attending schools of higher education.

COVERAGE: This is the second volume in a series of works on nonferrous and light-metal alloys prepared by the Institut metallurgii imeni A.A. Baykova AN SSSR (Institute of Metallurgy imeni A.A. Baykov of the Academy of Sciences USSR), and the Moskovskiy institut tsvetnykh metallov i zolota imeni M.I. Kalinina (Moscow Institute of Nonferrous Metals and Gold imeni M.I. Kalinin). The problems discussed concern the casting and physical metallurgy of nonferrous alloys, the effect of alloying and deformation on the properties of various alloys, and the problems connected with the study of the casting properties and with the plotting of phase diagrams for nonferrous alloys are discussed. No personalities are mentioned. References accompany most of the articles.

Spasskiy, A.G. The Growth of Individual Crystals in Nonferrous Metal Castings 135

[illegible], N.I., and Yu.A. Strashinskiy. Calcium Losses in the BK Bearing Alloy After Repeated Remelting 140

[illegible], M.V., and Yu.I. [illegible]likov. The Development of Porosity in Magnesium Alloy Castings 145

[illegible], L., and M.V. Mal'tsev. Modification of the β-Phase in Al-Mg Alloys [illegible]

Savitskiy, Ye.M., V.V. Baron and [illegible]. The Effect of Impurities on the Mechanical Properties of Chromium and Vanadium 177

Zakharov, M.V., [illegible], I.G. [illegible], and [illegible]. [illegible] New Copper Alloys for [illegible] Making of Glass 184

Gurevich, S.Ye. Estimating the Cyclic Strength of Bearing Alloys 189

[illegible], N.I. Properties of Tungsten-base and Other Refractory Materials 197

PHASE I BOOK EXPLOITATION SOV/4553
SOV/16-3-5

Akademiya nauk SSSR. Institut metallurgii

Metallurgiya, metallovedeniye, fiziko-khimicheskiye metody issledovaniya (Physicochemical Research Methods in Metallurgy and Metal Science) Moscow, Izd-vo AN SSSR, 1960. 251 p. (Series: Its: Trudy, vyp. 5) Errata slip inserted. 2,800 copies printed.

Sponsoring Agency: Akademiya nauk SSSR. Institut metallurgii imeni A.A. Baykova.

Resp. Ed.: I.P. Bardin, Academician (Deceased); Ed. of Publishing House: V.A. Klimov; Tech. Ed.: T.P. Polenova.

PURPOSE: This collection of articles is intended for metallurgists and metal researchers.

COVERAGE: The collection contains articles on metallurgy, metal science, and physicochemical research methods. Separate articles discuss the structure and properties of some metals and alloys. The effect of cold treatment and inclusions on the properties of alloys are analyzed, and instruments and

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SAVITSKIY, YE.M.

SAVITSKIY, Ye.M., doktor khim.nauk, otv.red.; SHAPOVALOV, I.K., red.;
KAMAYEVA, O.M., red.izd-va; ISLENT'YEVA, P.G., tekhn.red.

[Rare metals and alloys; transactions of the First All-Union
Conference on Rare Metal Alloys, November 18-20, 1957] Redkie
metally i splavy; trudy Pervogo Vsesoiuznogo soveshchaniia po
splavam redkikh metallov, 18-20 noiabria 1957 g. Moskva, Gos.
nauchno-tekhn.izd-vo lit-ry po chernoi i tsvetnoi metallurgii,
1960. 404 p. (MIRA 13:6)

1. Akademiya nauk SSSR. Institut metallurgii.
(Metals, Rare and minor) (Rare earth metals)

SAVITSKIY, YE.

SOV/4164

PHASE I BOOK EXPLOITATION

Vsesoyuznoye soveshchaniye po splavam redkikh metallov. 1st, Moscow, 1957

Redkiye metally i splavy; trudy... (Rare Metals and Alloys; Transactions of the First All-Union Conference on Rare-Metal Alloys) Moscow, Metallurgizdat, 1960. 438 p. 3,150 copies printed.

Sponsoring Agencies: Akademiya nauk SSSR. Institut metallurgii; USSR Komissiya po redkim metallam pri nauchno-tekhnicheskom komitete.

Ed.: I.K. Shapovalov; Ed. of Publishing House: O.M. Kamayeva; Tech. Ed.: P.G. Islent'yeva.

PURPOSE: This collection of articles is intended for metallurgical engineers, physicists, and workers in the machine-building and radio-engineering industries. It may also be used by students of schools of higher education.

COVERAGE: The collection contains technical papers which were presented and discussed at the First All-Union Conference on Rare-Metal Alloys, held in the Institute of Metallurgy, Academy of Sciences USSR in November 1957. Results of investigations of rare-metal alloys, titanium, and copper-base alloys with additions of rare metals are presented and discussed along with investigations of rhenium, vanadium, niobium, and their alloys. The effect of rare-earth metals

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on properties of magnesium alloys and steels is analyzed. The uses of rhenium as a dehydrating catalyst, electroplating material, and material suitable for making plugs for automobile electrical systems are discussed. Also, the effect of the addition of certain elements on the properties of heat-resistant steel is examined and alloys with special physical properties (particularly semiconductive alloys) are discussed. No personalities are mentioned. Soviet and non-Soviet references accompany some of the articles.

TABLE OF CONTENTS:

PART I. THE PRESENT STATE OF INVESTIGATION OF RARE-METAL ALLOYS

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Rare Metals (Cont.)

PART III. RHENIUM, VANADIUM, NIOBIUM, ZIRCONIUM AND ALLOYS BASED ON THEM

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PART IV. RARE-EARTH METALS AND THEIR EFFECT ON PROPERTIES OF MAGNESIUM ALLOYS

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SAVITSKIY, Ye. M.

TITLE: IV All-Union Conference on Physico-chemical Analysis

PERIODICAL: Atomnaya energiya, v. 10, no. 4, 1961, 406-407

TEXT: The IV Vsesoyuznoye soveshchaniye po fiziko-khimicheskomu analizu (IV All-Union Conference on Physico-chemical Analysis), convened by the Institut obshchey i neorganicheskoy khimii im. N. S. Kurnakova AN SSSR (Institute of General and Inorganic Chemistry imeni N. S. Kurnakov, AS USSR) and the Institut metallurgii im. A. A. Baykova AN SSSR (Institute of Metallurgy imeni A. A. Baykov, AS USSR), was held from December 6 to 10, 1960 on the occasion of the 100th anniversary of the birthday of N. S. Kurnakov. Part of the 142 reports made at the Conference dealt with problems of the atomic industry, including reports on the physico-chemical analysis of thorium, uranium, plutonium, and their alloys, as well as of zirconium and beryllium (O. S. Ivanov); "radiation phenomena and new problems of physico-chemical analysis" (V. I. Spitsyn); structure and constitution diagrams of the ternary systems thorium - zirconium - uranium (G. K. Alekseyenko and T. A. Badayeva), uranium - molybdenum - zirconium (G. N. Bagrov), uranium - zirconium - niobium (L. I. Gomozov), uranium - niobium - molybdenum (G. I. Terekhov); and physico-chemical analysis of metallic system with rare metals (Ye. M. Savitskiy). V. F. Terekhova reported experimental and theoretical data on rare-earth alloys and presented new constitution diagrams of alloys of yttrium, neodymium, and gadolinium with magnesium, of yttrium and neodymium with aluminum, and of gadolinium with iron and nickel; furthermore, she described the properties of the latter. M. A. Tylkina held a report on tests of alloys of rhenium, tantalum, and tungsten, and also on reactions between these alloys and elements of the 4th, 5th, 6th, 7th, and 8th group.

SAVITSKIY, Ye. M., and TYLKINA, M. A.

Certain Physical Properties of Rhenium and Its Alloys

E. M. Savitski and M. A. Tylkina, The Institute of Metallurgy of the Academy of Sciences of the U.S.S.R., Moscow, U.S.S.R.

Studies have been made of recrystallization of rhenium, and of alloying with tungsten, nickel (in Ni-Cr alloys), and with titanium and its alloys. Rhenium additions improve both room and elevated temperature properties and increase the initial recrystallization temperatures. Solid solution tungsten alloys have increased workability and electrical resistance. Applications for rhenium alloys are promising for thermocouples, electrical contacts and some vacuum tube parts. Results are given a study of rhenium as a contact material.

Report presented at the 117th Meeting of the Electrochemical Society, Chicago, 1-5 May 1960.

SAVITSKIY, Ye. M., and TYLKINA, M. A.

Rhenium and Transition Metals Phase Diagrams

E. M. Savitski and M. A. Tylkina, Institute of Metallurgy, Academy of Sciences of the U.S.S.R., Moscow, U.S.S.R.

Binary phase diagrams of rhenium with titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, tungsten, manganese, and cobalt have been determined. A number of these alloy systems are characterized by the formation of inter-metallic phases of the sigma or alpha-manganese types. Comparisons are made of these and other common features of the respective diagrams on the basis of the periodicity of the binary alloy additions.

Report presented at the 117th Meeting of the Electrochemical Society, Chicago, 1-5 May 1960.

KRIPYAKEVICH, P.I.; TYLKINA, M.A.; SAVITSKIY, Ye.M.

New compound in the rhenium-zirconium system and its crystal structure. Izv. vys. ucheb. zav.; chern. met. no.1:12-15 '60.

1. L'vovskiy gosudarstvennyy universitet i Institut metallurgii AN SSSR. (Rhenium-zirconium alloys--Metallography)

S/136/60/000/01/009/021
E091/E255

12 1295

AUTHORS: Savitskiy, Ye. M., Terekhova, V. F., and Naumkin, O. P

TITLE: Erbium and its Alloys

PERIODICAL: Tsvetnyye metally, 1960, Nr 1, pp 43-48 (USSR)

ABSTRACT: The authors have investigated the physico-mechanical properties of erbium and its reaction with a few of the metals commonly met in industry. These investigations are a continuation of a cycle of published studies, carried out at the laboratory of rare metal alloys of the Institute of Metallurgy, AS USSR on the physico-chemical properties of rare earth metals and their alloys (Refs 3 to 8). Metallic erbium of 99.35% purity was used for the study. It contained the following chief impurities: Nd 0.1%, Ho 0.28%, Tu 0.1%, Y 0.1%, Th 0.2%, Ca 0.02%, Fe 0.01% and Cu 0.007%. The microstructure of the original cast metallic erbium is shown in Fig 1. The hardness of metallic erbium (H_m) is 130 to 135 kg/mm^2 (Vickers). Its hardness after remelting in an argon atmosphere rose by 10 to 15 kg/mm^2. The density of erbium was determined by a hydrostatic method, and also by X-ray analysis. The results were respectively

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9.01 and 9.06 g/cm^3. The melting point of erbium, as determined on three specimens, was 1550° ± 20°C. The vapour pressure of metallic erbium was determined by the Knudsen method. Evaporation from a Knudsen cell was carried out on a target (mica plate) suspended from one of the ends of an arm of a vacuum torsion micro-balance (sensitivity = 10^{-7} g) in the same vacuum apparatus. Thus, the rate of evaporation was determined from the gain in weight due to the metal condensed on the target in vacuum without exposing the target to air (Table [illegible] and Fig 2). The experimental results yield an equation for the temperature dependence of the saturated vapour pressure (measured in mm Hg) in the following form:

$$\log P = \frac{14145 \pm 465}{T} + 6.629 \pm 0.315$$

The heat of evaporation, calculated from these data has been found to be ΔH_{evap} = 64.75 ± 0.215 kcal/g.atom. The boiling point of erbium, as calculated from the

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E091/E253

Erbium and its Alloys

graph of the dependence of log P on 1/T, is 2650°C. The lattice parameters of erbium have been determined by X-ray analysis. It has been found that erbium has a hexagonal close-packed lattice with parameters a = 3.55 Å, c = 5.59 Å and the axial ratio c/a = 1.57. The authors have established the hardness, strength and plasticity in tension and compression. The Brinell hardness of erbium at a load of 250 kg and using a ball of 5 mm diameter, is 95 to 100 kg/mm². Compression tests were carried out in a Gagarin press; the specimens were cylinders of 5 mm diameter and 7 mm length. The UTS of erbium in compression at room temperature is 78 kg/mm², and its plasticity (percentage contraction) is 22%. Tension tests were carried out in a Shavenar micromachine in which the extension diagrams were registered photographically. The strength and plasticity properties, as calculated from the extension diagram, have the following values: UTS = 29 kg/mm², limit of proportionality = 19 kg/mm²; the percentage elongation does not exceed 1 to 2% and no reduction in

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Erbium and its Alloys

area was observed. The authors have studied the physico-chemical reactions of erbium with the basic components of industrial alloys - Mg, Al, Fe, Ti and Ta. Alloys were cast of the above metals with additions of 5 wt.% erbium. Fig 3 shows the microstructure of an Al-5% erbium alloy, Fig 4 that of an Fe-5% erbium alloy and Fig 5, that of a tantalum-erbium alloy. It was found that erbium in quantities of 5% can be melted with Al, Mg, Fe and Ti with the formation, in all cases, of 2-phased mixtures of the eutectic of peritectic type. For all investigated alloys, erbium is a good modifier and strengthener. It does not alloy with Ta. As erbium is extremely rare and expensive, it cannot be used as an alloying element for industrial alloys. Its fields of application can be in construction of special instruments, in electronic apparatus and in other directions where its particular physical properties (eg ferromagnetism, optical properties, etc) can be exploited. The further study of erbium and its alloys must concentrate on the complex of physico-chemical

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E091/E255

Erbium and its Alloys

properties, with the aim of developing precision alloys with special physical properties. There are 5 figures, 1 table and 11 references, 9 of which are Soviet, 1 German and 1 English.

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S/180/60/000/01/009/027
E071/E135

18.1200

AUTHORS: Baron, V.V., Yefimov, Yu.V., and Savitskiy, Ye.M. (Moscow)

TITLE: The Structure and Properties of Alloys of the Vanadium-Tungsten System

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1960, Nr 1, pp 70-74 (USSR)

ABSTRACT: The microstructure, hardness, plasticity, strength and susceptibility to oxidation of vanadium-tungsten alloys in the whole range of concentrations was investigated. The following starting materials were used: vanadium, 98.6% V, 0.3% C, 0.5% oxygen, 0.2% nitrogen, 0.06% sulphur and less than 0.2% of metallic admixtures; tungsten, 99.95% Wo, 0.032% Mo, remaining oxygen and nitrogen. About 40 g samples of alloys were melted in an arc furnace with non-consumable tungsten electrodes in a medium of helium under pressure of 0.5 atm. In all cases the content of tungsten was 1% higher than in the starting charge. Cast alloys were annealed at 1100 °C for 500 hours in double quartz sheaths, evacuated and sealed. Specimens for the investigation were prepared

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The Structure and Properties of Alloys of the Vanadium-Tungsten System

by anode cutting with subsequent polishing. The solidus temperatures were determined by the drop method, metallographic and X-ray analyses by the usual methods, hardness by the Vickers apparatus, plasticity and strength on compression of specimens 4 x 4 x 6 mm in a "Gagarin" press, and the susceptibility to oxidation on heating in air by the gravimetric method (increase in weight, or decrease in weight after mechanical or chemical removal of the scale formed). In some cases the scale was chemically analysed. On the basis of the results obtained the equilibrium diagram of the system vanadium-tungsten was constructed (Fig 1). Vanadium and tungsten form a continuous series of solid solutions. The solidus and liquidus curves possess a sharply expressed minimum at 4.5 at.% of tungsten equal to 1635 °C. However, no transformations in the solid state in alloys, corresponding to this section of the diagram, were observed. Small additions of tungsten to vanadium (of the above quoted purity) cause an increase in

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The Structure and Properties of Alloys of the Vanadium-Tungsten System

plasticity, a decrease in hardness and a small increase in the compression strength. Further increase in the content of tungsten causes changes in properties, characteristic for systems with continuous solubility in the solid state. Vanadium decreases the resistance of tungsten to oxidation. At temperatures between 700 and 1100 °C all alloys as well as starting metals are strongly oxidised and require protection (Fig 3). The microstructure of annealed vanadium-tungsten alloys is shown in Fig 2.

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There are 3 figures and 2 references, of which 1 is English and 1 is German. There is also a table (p 70).

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SUBMITTED: July 2, 1959

SAVITSKIY, Ye.M.; BARON, V.V.; YEFIMOV, Yu.V.

Effect of admixtures on the mechanical peoperties of "carbothermal" vanadium. Issl.splav.tsvet.met. no.2:177-183 '60. (MIRA 13:5)

(Vanadium--Metallurgy)

DASHKOVSKIY, A.I.; YEVSTYUKHIN, A.I.; SAVITSKIY, Ye.M.

Equipment for the measurement of internal friction in metals and alloys. Met. i metalloved. chist. met. no. 2:207-213 '60. (MIRA 13:12)

(Internal friction--Measurement)
(Measuring instruments)

DASHKOVSKIY, A.I.; SAVITSKIY, Ye.M.

Temperature relation of internal friction, modulus of normal elasticity and modulus of shear in zirconium, niobium and zirconium-niobium alloys. Met. i metalloved. chist. met. no. 2:214-223 '60. (MIRA 13:12)

(Zirconium--Thermal properties)
(Niobium--Thermal properties) (Phase rule and equilibrium)

DASHKOVSKIY, A.I.; YEVSTYUKHIN, A.I.; SAVITSKIY, Ye.M.; SKOROV, D.M.

Temperature relation of internal friction and the shear modulus of uranium. Met. i metalloved. chist. met. no. 2:224-228 '60. (MIRA 13:12)

(Uranium--Thermal properties)
(Internal friction)

80981

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18.1210

S/180/60/000/03/013/030
E193/E383

AUTHORS: Savitskiy, Ye.M., Stepanov, Ye.S. and Terekhova, V.F. (Moscow)

TITLE: Neodymium and Its Alloys with Aluminium

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1960, Nr 3, pp 73 - 78 (USSR)

ABSTRACT: The object of the present investigation was to determine the physical and mechanical properties of pure (99.5%) neodymium and neodymium-aluminium alloys. The following properties were determined for cast neodymium: Brinell hardness 46 kg/mm^2; ultimate compressive strength - 25 kg/mm^2; ductility (in compression) - 36%. It has been found that neodymium is characterised by good, both hot and cold, workability, it being possible to produce neodymium strip, 0.5 mm thick, by cold-rolling with intermediate annealings at 500 - 600 °C. Neodymium, cold-rolled to 70% reduction in thickness, had the UTS equal to 13 kg/mm^2 and ductility (in tension) equal 1-2%. The constitution diagram of the aluminium-neodymium system, constructed on the basis of metallographic and thermal analysis, is shown in Figure 3. It has been found that

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E193/E383

Neodymium and Its Alloys with Aluminium

solid solubility of neodymium in aluminium does not exceed 0.2%. A eutectic, containing approximately 13 wt.% neodymium, is formed at about 640 °C. In the investigated concentration range: the existence of two intermetallic compounds, $NdAl_4$ and $NdAl_2$, has been observed. The former is formed as a result of a peritectic reaction at 1 250 °C; the latter crystallizes out from the liquid phase at 1 450 °C. Owing to the formation of the intermetallic compounds, addition of neodymium to aluminium increases the strength of the latter metal. Hardness of an aluminium-base alloy containing 30 wt.% neodymium is 155 kg/mm^2, as compared with 25 kg/mm^2 for pure aluminium; addition of 5% neodymium increases the UTS of aluminium from 5 to 10 kg/mm^2 and lowers its ductility by 5-10%. Hardness of the intermetallic compounds $NdAl_4$ and $NdAl_2$ is 350 and 600 kg/mm^2, respectively. The electrical restivity of aluminium is not significantly affected by addition of neodymium; resistivity of the

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E193/E383

Neodymium and Its Alloys with Aluminium

5% Nd-Al alloy is practically equal to that of pure aluminium. The effect of temperature up to 300 °C on the mechanical properties of the Al-Nd alloys with up to 5% Nd has been also investigated. Figure 1 shows the microstructure of neodymium (a) cast, (b) after 70% cold deformation and (c) after cold deformation to 70% and annealing at 500 °C. Figure 2 shows the microstructure of the aluminium-neodymium alloys (cold-worked and annealed), containing 0, 0.74, 1.05, 9.24, 24.21, 47.47 and 66% neodymium. There are 3 figures, 2 tables and 9 references, 7 of which are Soviet and 2 English.

SUBMITTED: March 2, 1960

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82628
S/180/60/000/004/023/027
E111/E452

18.1200

AUTHORS: Baron, V.V., Ivanova, K.N. and Savitskiy, Ye.M.
(Moscow)

TITLE: Phase Diagram and Some Properties of Alloys of the System Niobium-Molybdenum-Vanadium

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1960, No.4, pp.143-149 + 1 plate

TEXT: The microstructures in the as-cast and annealed states (Fig.1), hardness (Fig.2,5), melting points (table) were determined for the ternary Nb-Mo-V (and corresponding binary) systems. The solidus isotherms are projected on the triangular diagram and the corresponding binary fusion diagrams are plotted in Fig.3. A continuous solid-solution range for the ternary system was found. The solidus-isotherms show that the fusion temperature of the alloys falls (from 2450 to 1800°C) as the vanadium rises. At the niobium corner of the diagram, alloys had the lowest hardness (105 to 220 kg/mm^2). The oxidation of the alloys at 1000 to 1200°C was also studied: specimens were placed in crucibles pre-ignited to constant weight, the gain in

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Phase Diagram and Some Properties of Alloys of the System Niobium-Molybdenum-Vanadium

weight for 1 hour's heating in air being determined. The results (shown by curves "v" in Fig.2 and 4) indicated that the best resistance to scaling is possessed in the binary systems by 5% Mo, 5% V (at 1000 °C) and 15.4% Mo, 2.4% V (at 1200 °C); and in the ternary by alloys with 5% Mo, 2.8% V and 5% Mo, 5.6% V, which also have other advantageous properties. A common feature of all alloys with high molybdenum and vanadium contents is a high oxidation rate. Variation of hardness with composition in binary and ternary alloys corresponded to property changes characteristic for a continuous series of solid solutions. Variation of scaling resistance with composition does not show such a relation. In general, increase in scaling resistance of the ternary niobium alloys occurred at a lower degree of alloying than with binary alloys. Some ternary alloys oxidized faster at 1000 than at 1200 °C. There are 5 figures, 1 table and 8 references: 3 Soviet and 5 English.

SUBMITTED: April 1, 1960

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89639

S/509/60/000/004/019/024
E021/E106

18.1150

AUTHORS: Savitskiy, Ye.M., Tylkina, M.A., Ipatova, S.I., and Pavlova, Ye.I.

TITLE: Physico-Mechanical Properties of Tungsten and Rhenium

PERIODICAL: Akademiya nauk SSSR. Institut metallurgii. Trudy, No.4, 1960. Metallurgiya, metallovedeniye, fiziko-khimicheskiye metody issledovaniya, pp.214-229

TEXT: Rhenium has been suggested as a possible alternative for tungsten for use in the electro-vacuum industry, but it is very expensive. Therefore an investigation of tungsten-rhenium alloys was carried out. Alloys were prepared in an arc furnace and by powder metallurgical methods. The complete range of alloys was studied by metallographic and X-ray analysis, by micro-hardness measurements and by measuring melting points. The formation of the compound W_2Re_3 (σ phase) in the region 48-65 wt.% rhenium and the formation of a eutectic between the σ phase and the rhenium solid solution at 75 wt.% rhenium and 2815 °C were confirmed. No eutectic between W_2Re_3 and tungsten was found.

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E021/E106

Physico-Mechanical Properties of Tungsten and Rhenium

There was a wide range of solid solutions of rhenium in tungsten (up to 30%) at high temperatures, with decreasing solubility as the temperature was decreased. The compound W_2Re_3 formed by a peritectic reaction possessed a high hardness (about 2000 kg/mm^2) and was brittle. A method was developed for preparing wire of diameter 12 microns from alloys with a maximum rhenium content of 20 wt.%. The wire was prepared by hot-working samples prepared by powder metallurgical methods. The introduction of rhenium into tungsten raised the temperature of the beginning of recrystallization by 200-400 °C depending on the rhenium content. Grain growth of tungsten-rhenium alloys was less intensive than that of tungsten. The tungsten-rhenium alloys retained a high strength and possessed considerable ductility after annealing at 1400-1950 °C. The initial strength of 100 micron tungsten wire was 320 kg/mm^2 with an elongation of 1-5%. After heating at 1950 °C the strength decreased to 80 kg/mm^2, and elongation was 0. The alloy containing 21% rhenium in these conditions decreased in strength from 370 to 150 kg/mm^2 and the elongation increased from

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E021/E106

Physico-Mechanical Properties of Tungsten and Rhenium

1.5 to 6-8%. After annealing at 1400-1500 °C, the strength of this alloy was 180-190 kg/mm2 and its elongation 18-20%. The strength of wires of the alloys was higher than that of tungsten wires at all temperatures, although an increase in temperature resulted in a decrease in strength. At 1400 °C the U.T.S. of tungsten was 42 kg/mm2 and that of an alloy containing 19% rhenium was 66.7 kg/mm2. At 2600 °C the figures were 4 and 6.7 kg/mm2 respectively. The limiting testing temperature of alloys containing 10 and 20% rhenium was 3000 °C, or 300° higher than the limiting temperature of tungsten or alloys containing 1 and 3% rhenium. The hardness of cast tungsten-rhenium alloys was tested in the range 20-1000 °C. At 800 °C alloys containing 10, 25 and 75% rhenium and pure rhenium had a hardness of about 200 kg/mm2. Tungsten and alloys containing 10% rhenium had a hardness of 100 kg/mm2. The electrical resistance of 50-micron wires of the alloys was measured at 20 to 1350 °C. At any given temperature the resistance was higher with higher rhenium contents.

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E021/E106

Physico-Mechanical Properties of Tungsten and Rhenium

At 20 °C the resistance of tungsten was 0.056 ohm.mm^2/m, and that of the alloy containing 21% rhenium was 0.242 ohm.mm^2/m. At 1600 °C the resistances were 0.44 and 0.644 ohm.mm^2/m respectively. Thus the tungsten-rhenium alloys possessed several advantages over tungsten.
There are 11 figures and 23 references: 19 Soviet and 4 English.

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89640

S/509/60/000/004/020/024
E111/E152

18.1235

AUTHORS: Savitskiy, Ye.M., Baron, V.V., and Yefimov, Yu.V.

TITLE: Phase Diagram and Properties of Vanadium—Chromium Alloys

PERIODICAL: Akademiya nauk SSSR. Institut metallurgii. Trudy, No.4, 1960. Metallurgiya, metallovedeniye, fiziko-khimicheskiye metody issledovaniya, pp.230-235

TEXT: The authors describe their work on the vanadium—chromium phase diagram. Their starting materials were: alumino-thermic vanadium (95.5% V, 1.0 Al, 0.15 Fe, 0.2 C, 0.3 Si, considerable concentration of oxygen) and electrolytically refined chromium (99.9% Cr, 0.02 Fe, 0.03 Si, 0.02 N, 0.002 H, 0.0023 O). Alloys were arc melted (non-consumable tungsten electrode) under helium, each ingot of 50 g being remelted four times and analysed. Compositions of the charges and alloys are shown in the first two main columns of a table. Solidus and liquidus temperatures were determined under argon in an apparatus constructed in the Laboratoriya splavov redkikh elementov IMET AN SSSR (Laboratory of Alloys of Rare Elements, IMET AS USSR). Specimens were heated by

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Phase Diagram and Properties of Vanadium--Chromium Alloys

current from a type ОСУ-40 (OSU-40) transformer; temperature was determined with an optical pyrometer calibrated under similar conditions against melting points of pure nickel, titanium, zirconium, niobium and molybdenum. Liquidus temperature was the reading when the specimen lost cohesion; the solidus, that when a hole drilled in the 4 x 4 x 15 mm specimen fused over. Curves 1 and 2 in Fig.1 show plots of these temperatures against wt.% Cr (the relatively low value for vanadium is due to impurities). Microstructure was studied and hardness measured on the cast alloys and alloys annealed for 100 hours at 1100 °C in evacuated quartz capsules and slowly cooled. The hardness (H_k, kg/mm^2) results are shown in Fig.1; curves III and IV correspond to the cast and annealed states respectively, and curve V gives hardness at 1000 °C (annealed alloys). Hardness was determined with a 50-kg load on a "pobedite" cone, in argon at the high-temperature which was measured with a Pt/Pt-Rh thermocouple. Electrical resistivity of annealed 4 x 4 x 15-20 mm specimens was determined potentiometrically at room temperature; results are

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Phase Diagram and Properties of Vanadium—Chromium Alloys

shown in curve VI of Fig.1. The work showed that a continuous range of solid solutions is formed. Increase in concentration of the second component produces a rise in both hardness and resistivity.
There are 2 figures, 1 table and 3 English references.

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E111/E152

Phase Diagram and Properties of Vanadium—Chromium Alloys

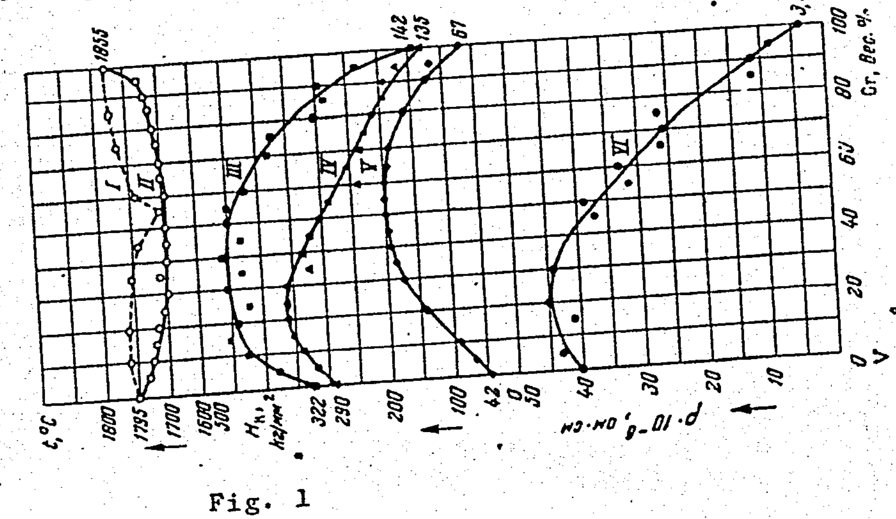

Рис. 1. Диаграмма состояния и свойства

Fig. 1

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E111/E135

1416, 1454

18.1200
18.1152

AUTHOR: Savitskiy, Ye.M. (Moscow)

TITLE: Rare Metals in Heat-Resisting Alloys 18

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1960, No. 5, pp. 52-69

TEXT: The author carried out much work (e.g. Refs 2, 3, 18, 25 and 34) on rare metals and alloys of them. In the present paper, using published information, he discusses possibilities of using rare metals as bases for heat resisting alloys, and their effect on heat-resisting alloy properties. Table 1 shows the main physical and mechanical properties of high-melting metals and draws some general conclusions for discussion, while Table 2 gives solubilities of carbon, 27 oxygen, 27 nitrogen, 27 and hydrogen 27 in some of these metals. The author goes on to discuss the properties of alloys based on individual rare metals. The first is rhenium, which the author considers reliably established as the only component for good mechanical properties at 2000-3000 °C. Tantalum is another promising alloy base but, like rhenium, 27 is scarce. 27 Niobium 27 is more plentiful, but liable to oxidation, while vanadium 27 has a relatively low melting point. Hafnium 27 and zirconium 27 are considered by the

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author unsuitable as bases for very high-temperature alloys, but having good corrosion resistance. Yttrium has some advantageous properties. The author urges further studies on this element and on lutetium, thullium, erbium, holmium and scandium. In the section on the influence of rare metals on heat-resisting alloy properties, the author discusses the following possible effects: grain refining of the alloy base (pure metal or solid solution based on it) as exemplified in Fig. 3; elimination of impurities (e.g. oxygen, hydrogen) producing brittleness; conversion of low-melting eutectoidal inclusions (e.g. sulphur in steels) producing red shortness into high-melting compounds; improvement of resistance of scale to further oxidation; change in mechanism of plastic deformation of the alloy base (the influence of rhenium on the deformability of tungsten is shown in Fig. 7); increased recrystallization temperature (the effect of various elements on that of molybdenum is shown in Fig. 9); strengthening action through alloying of solid solution or formation of new heat-resisting compounds, or their redistribution in heat treatment

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(Fig. 11 shows the effect of small additions of cerium on the strength of titanium alloys); imparting of special properties to alloys. The author concludes from this survey that rare metals are needed for high-temperature alloys and urges wider and more profound research work in this field.
There are 12 figures, 7 tables and 51 references: 42 Soviet (several are translations from English), and 9 English.

SUBMITTED: April 25, 1960

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SAVITSKIY, Ye.M.; BARON, V.V.

Investigating the structure and the physicomechanical properties of molybdenum disilicide alloys with nickel, cobalt, vanadium and niobium. Trudy Inst.met. no.5:156-161 '60. (MIRA 13:6)
(Molybdenum alloys--Testing)
(Molybdenum silicide)

SAVITSKIY, Ye.M.; BARON, V.V.; YEFIMOV, Yu.V.

Constitutional diagram of the V - La system. Trudy Inst.met. no.5: 166-173 '60. (MIRA 13:6)

(Vanadium-lanthanum alloys--Metallography)
(Phase rule and equilibrium)

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Savitskiy, Ye.m.

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AUTHORS: Savitskiy, Ye.M.; Duysemaliyev, U.K.

TITLE: The Effect of Vanadium on the Properties of Industrial Nickel-Base Alloys

PERIODICAL: Vestnik akademii nauk Kazakhskoy SSR, 1960, No. 6, pp. 43 - 47

TEXT: The authors describe experiments carried out to determine the effect of vanadium on structure and properties of Monel metal and constantan. The alloys were prepared at the Balkhashskiy zavod po obrabotke tsvetnykh metallov (Balkhash Non-Ferrous Metal Working Plant) and the vanadium was introduced in the form of a Ni + 10% V alloy. They were tested as to microstructure, hardness, electric resistance, strength and plasticity during stretching. The stretching tests were carried out at temperatures of from 20 to 1,100°C. Additions of vanadium of up to 0.5% had no effect on the microstructure of either the Monel metal or the constantan. Measuring the hardness of the alloys in the deformed and tempered phases showed that the introduction of up to 0.5% vanadium had no effect on the hardness of the Monel metal and slightly increased the hardness of the constantan. The va-

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