

THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

Armed Services Technical Information Agency

Because of our limited supply, you are requested to return this copy WHEN IT HAS SERVED YOUR PURPOSE so that it may be made available to other requesters. Your cooperation will be appreciated.

AD

40705

NOTICE: WHEN GOVERNMENT OR OTHER DRAWINGS, SPECIFICATIONS OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE U. S. GOVERNMENT THEREBY INCURS NO RESPONSIBILITY, NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.

Reproduced by
DOCUMENT SERVICE CENTER
KNOTT BUILDING, DAYTON, 2, OHIO

UNCLASSIFIED

AD No. 40 705
ASTIA FILE COPY

FILE COPY
Return to:
Library Section - DSC SL
Service Division
ASTIA
Document Service Center

FILE COPY
Return to
ASTIA
DOCUMENT SERVICE CENTER
Knott Building, Dayton 2, Ohio
Attn: DSC-SD11

- Released on DSC Order No.
1. 15183
 2. _____
 3. _____
 4. _____
 5. _____
 6. _____
 7. _____
 8. _____

FILE COPY
NAVY RESEARCH SECTION
SCIENCE DIVISION
LIBRARY OF CONGRESS
First and Second Station Reports on Task Order N6onr-22528, NR 034-404
For the periods June 16-September 15, 1951, and September 16-December 15, 1951
The Ohio State University Research Foundation
TO BE RETURNED

PROTECTION OF MOLYBDENUM AGAINST CORROSION AT HIGH TEMPERATURES

1. EXPERIMENTAL RESEARCH IN PROGRESS:

- a. Stability of the Binary Alloys Mo-Si, Mo-Ni and Mo-Al Against Oxidation.

Graded ingots of Mo-Si, Mo-Ni and Mo-Al have been obtained from Robert M. Parke of Battelle Memorial Institute. The stability of these alloys in oxidizing atmospheres are being investigated. The character and structure of the oxide formed on these alloys are being studied with the object of ascertaining the prerequisite physical and chemical characteristics of protective oxide films. The graded ingots are ground flat and then polished. The sample is oxidized and the surface of the alloy is examined metallographically, by x-ray analysis and chemically.

- b. The Replacement Reaction in the Oxidation of Binary Alloys of Molybdenum.

In line with the philosophy that the engineering solution to protection of molybdenum against oxidation must come from within, that is by alloying, rather than by external coatings, work has been undertaken to explore the feasibility of the "replacement reaction" in developing protective oxide scales on molybdenum. The principal requirement for the replacement reaction is a solute whose heat of formation of the oxide is considerably higher than that for the solvent. Wagner* gives an example of the replacement reaction in the oxidation of brass. After one hour at temperature in air, an oxide of copper was formed. After 3 hours at the same temperature in an inert atmosphere, the oxide was entirely converted to zinc oxide since zinc oxide is more stable than copper oxide. This, then, is a method of forming an oxide of the solute when the concentration of the solute is relatively low. This is attractive in molybdenum because any decrease in rate of oxidation comes about only at high concentrations of the solute atom. Although this method is probably not entirely self generating, it may be considered to be semi-self generating. It has the additional advantage of developing oxides of the solute at low concentrations at which they may be useful in the enhancement of mechanical properties.

NAVY RESEARCH SECTION
SCIENCE DIVISION
REFERENCE DEPARTMENT
LIBRARY OF CONGRESS

*C. Wagner - High Temperature Oxidation of Metals, Society for Metals, Cleveland, Ohio, 1951.

JAN 23 1952

The replacement reaction is to be studied in the systems Mo-Cr, Mo-Zr, Mo-Ti, Mo-Al, and Mo-Si. All of these solute atoms have significantly higher heat of formation than does molybdenum oxide. The first alloy being studied is a Mo-1% Cr alloy. The procedure is to form molybdenum oxide, heat in an inert atmosphere until the oxide is converted to chromium oxide, and finally to make oxidation tests in air on these samples.

c. The effect of the Interstitial Solution of Carbon, Nitrogen and Oxygen on the Physical Properties of Molybdenum.

The effect of the solid solution of carbon, nitrogen and oxygen on the lattice parameters of molybdenum are being investigated in collaboration with staff members of Battelle Memorial Institute. The study of the effect of carbon has been completed and a Technical Report and a paper to be published in the Journal of Metals in February, has been completed.

At the present time, the effect of nitrogen on the lattice parameter of molybdenum is being studied. Preliminary x-ray measurements show some promise of yielding tangible results.

2. THEORETICAL RESEARCH, PAPERS, AND TECHNICAL REPORTS

a. A monograph to be published by the Engineering Experiment Station of The Ohio State University, is in preparation and will be completed in the near future. The title and authors are, "The Theoretical Prediction of the Phase Diagrams of Binary Alloys", by Rudolph Speiser, J.W. Spretnak and W.J. Taylor.

b. "Interstitial Solid Solution in Body-centered Cubic, Face-centered Cubic and Hexagonal Metals", by Rudolph Speiser, J.W. Spretnak and W.J. Taylor. This paper is to be submitted to the A.I.M.E.

c. Technical Report No. 1, dated November 1951, "The Oxidation Characteristics of Molybdenum at High Temperatures", has already been submitted for distribution.

A paper entitled "The Oxidation Characteristics of Molybdenum at High Temperatures", by E.S. Jones, J.W. Spretnak and Rudolph Speiser, is being prepared for publication in the A.S.M.

d. Technical Report No. 2, January 1952, "The Effect of Carbon on the Lattice Parameter of Molybdenum", is now being submitted for distribution.

A paper entitled "The Effect of Carbon on the Lattice Parameter of Molybdenum", by Rudolph Speiser, J.W. Spretnak, W.E. Few and R.M. Parke, is to be published in the February issue of the "Journal of Metals", and is to be presented at the A.I.M.E., Annual Convention in New York City in February.

Chief Investigators:

Rudolph Speiser
Associate Professor, Department of Metallurgy

J. W. Spretnak
Associate Professor, Department of Metallurgy

STATUS REPORT DISTRIBUTION LIST

Commanding Officer Office of Naval Research Branch Office 844 North Rush Street Chicago 11, Illinois Attention: Mr. J.A. Bryson (2)	Maddin, Dr. Robert The Johns Hopkins University Baltimore 18, Maryland (1)
Driggs, Dr. F.H. Vice President Fansteel Metallurgical Corporation North Chicago, Illinois (1)	Mesick, Colonel B.S. Office of the Chief of Ordnance, OPDTB Department of the Navy Washington 25, D.C. (1)
Duwez, Dr. Pol California Institute of Technology Pasadena 4, California (1)	Miller, E.C. Metallurgy Division Oak Ridge National Laboratory Oak Ridge, Tennessee (1)
Gensamer, Dr. Maxwell Professor of Metallurgy School of Mines Columbia University New York 27, New York (1)	Nachtman, John St. Bureau of Ordnance Attention Re9a Washington 25, D.C. (1)
Harwood, J.J. Metallurgy Branch (Code 423) Office of Naval Research Navy Department Washington 25, D.C. (2)	Nisbet, James D. Research Laboratories General Electric Company Schenectady, New York (1)
Herty, Dr. C.H., Jr. Bethlehem Steel Company Bethlehem, Pa. (1)	Officer in Charge Office of Naval Research Navy #100 Fleet Post Office New York, New York (2)
Jackson, Eugene B., Chief Office of Aeronautical Intelligence National Advisory Committee for Aeronautics Washington, D.C. (1)	Ordnance Department Springfield Armory Springfield, Mass. Attention: Mr. H.P. Langston (1)
Chief of Metallurgical Group Office of Air Research MCRR (MCRRXS) Wright-Patterson Air Force Base Dayton, Ohio Attention: Mr. J.B. Johnston (1)	Parke, Robert M. Battelle Memorial Institute 505 King Avenue Columbus 1, Ohio (1)
Bureau of Ships (Code 343) Navy Department Washington 25, D.C. (4)	Perella, F. United States Atomic Energy Commission Production Division Defense Requirements Branch Washington 25, D.C. (1)
Loeb, Carl M., Jr. Vice President Climax Molybdenum Company 500 Fifth Avenue New York 18, New York (1)	Promisel, N.E. Room 1466 Bureau of Aeronautics Department of the Navy Washington 25, D.C. (1)

Scott, Head
Westinghouse Electric Company
Manager, Metallurgical and
Ceramic Department
Research Laboratories
East Pittsburgh, Pa.

(1)

Speiser, Dr. Rudolph
Department of Metallurgy
Ohio State University
Columbus, Ohio

(1)

Timmons, George
Climax Molybdenum Company
14410 Woodrow Wilson Avenue
Detroit 3, Michigan

(1)

ONR London, c/o Fleet P.O.
Navy 100, New York, N.Y.
for transmittal to
Armament Research Establishment
Metallurgical Branch
Ministry of Supply
Woolwich S.A., 18, England

(1)

Applied Physics Laboratory
Silver Spring, Maryland

(1)

Wright-Field Development Center
Wright-Patterson Air Force Base
Dayton, Ohio
Attention: Materials Laboratory
Power Plant Laboratory

(2)

Chief, Bureau of Aeronautics
Navy Department
Washington 25, D.C.
Attention: AE 31
TD 41

(1)

(1)

Commander
Naval Air Material Center
Attn: Aeronautical Materials
Laboratory

(1)

Commander, NAMTC
Pt. Mugu, California
Attention: Eng. Dept.

(1)

Navy Liaison Officer for Guided
Missiles
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

(1)

Director
Naval Research Laboratory
Washington 25, D.C.
Attention: Tech Info Officer

(5)

British Joint Service Mission
1800 K St., N.W.
Washington, D.C.
Attention: Miss Scott

(1)

National Advisory Committee
for Aeronautics
Lewis Flight Propulsion Laboratory
Cleveland, Ohio

(1)

Armed Services Technical Information Agency

Because of our limited supply, you are requested to return this copy WHEN IT HAS SERVED YOUR PURPOSE so that it may be made available to other requesters. Your cooperation will be appreciated.

AD

40705

NOTICE: WHEN GOVERNMENT OR OTHER DRAWINGS, SPECIFICATIONS OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE U. S. GOVERNMENT THEREBY INCURS NO RESPONSIBILITY, NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.

Reproduced by
DOCUMENT SERVICE CENTER
KNOTT BUILDING, DAYTON, 2, OHIO

UNCLASSIFIED