HEDL--7450 DE84 013934

IRRADIATION OF COPPER ALLOYS IN FFTF

H. R. Brager and F. A. Garner
May 23, 1984

A Contribution to Damage Analysis and Fundamental Studies Quarterly Progress Report,

DOE/ER-0046/17.

HANFORD ENGINEERING DEVELOPMENT LABORATORY
Operated by Westinghouse Hanford Company, a subsidiary of
Westinghouse Electric Corporation, under the Department of
Energy Contract No. DE-AC06-76FF02170
P.O. Box 1970, Richland, Washington 99352

COPYRIGHT LICENSE NOTICE

By acceptance of this article, the Publisher and/or recipient acknowledges the U.S. Government's right to retain a nonexclusive, royalty-free license in and to any copyright covering this paper.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the U.S. Department of Energy (DOE), nor any of its employes, nor any of its contractors, subcontractors or their employes, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for any third party's use or the results of such use of any information, apparatus, product or process disclosed in this report, or represents that its use by such third party would not infringe privately owned rights.



IRRADIATION OF COPPER ALLOYS IN FFTF

H. R. Brager and F. A. Garner (Hanford Engineering Development Laboratory)

1.0 Objective

The object of this effort is to provide data on the response of a high-conductivity, high-strength series of copper alloys to high fluence neutron irradiation and thereby predict their behavior in anticipated fusion environments.

2.0 Summary

Nine copper-base alloys in thirteen material conditions have been inserted into the MOTA-18 experiment for irradiation in FFTF at ~450°C. The alloy Ni-1.9Be is also included in this experiment, which includes both TEM disks and miniature tensile specimens.

3.0 Program

Title: Irradiation Effects Analysis (AKJ)

Principal Investigator: D. G. Doran

Affiliation: Hanford Engineering Development Laboratory

4.0 Relevant DAFS Program Plan Task/Subtask

II.C.1 Effect of Material Parameters on Microstructure

5.0 Accomplishments and Status

5.1 Introduction

The use of high-conductivity high-strength copper-base alloys is anticipated for use in operation of fusion devices, particularly in the magnets and high heat-flux components.

There is very little data available on the response of such alloys to high levels of neutron exposure, however. The temperature range of anticipated use is <500°C, with the major applications below 300°C.

An opportunity recently arose to include a series of copper-base alloys in the MOTA-18 experiment currently being irradiated in the Fast Flux Test Facility (FFTF). The lowest temperature available in this experiment is ~450°C due to the use of helium rather than sodium as a thermal conduction medium. The experiment is targeted to reach four exposure levels: 15, 45, 105 and 150 dpa.

As shown in Table 1 there are nine copper alloys, some of which are in more than one starting material condition. Table 1 also shows that a high-conductivity high-strength Ni-1.9Be alloy and AISI 316 were included, the latter to provide a reference state for the experiment. There are three sets of specimens presently being irradiated, one targeted for each fluence level and the fourth set to be inserted at a later time. Each set contains 14 miniature tensile specimens whose electrical conductivities were measured before irradiation and 30 TEM disk specimens, the latter to be used for microscopy and material properties testing.

6.0 References

None

7.0 Future Work

Experiments targeted to irradiate copper-base alloys at lower temperatures are also being designed.

8.0 Publications

None

TABLE 1 CONTENTS OF COPPER-MOTA-18 EXPERIMENT

ALLOYS SUPPLIED BY INESCO

Material	Composition	Condition
Cu Ag	Cu - 0.1 Aq	CW
Cu Ag P	Cu - 0.5 Ag06 P08 Mg	CWA
A1-25	Cu - 0.25 Al ₂ 03	CW, SA
MZC	Cu - 0.9Cr - 0.1Zr - 0.05 Mg	CWA
Cu Be Ni	Cu - 1.8Ni - 0.3 Be	CWA, SA&T
Cu Be	Cu - 2.0 Be	CWA, SA&T
Ni Be	Ni - 1.9 Be	CWA

ALLOYS SUPPLIED BY HEDL

Cu - 5% Ni }	These alloys used in	CM .
Cu - 5% A1	previous RTNS-II studies	CW
Cu (99.999%)		CW, SA
AISI 316 '		CM

SA = Solution-annealed
CW = Cold-worked
CWA = Cold-worked and aged
T = Tempered

Form DOE 425 (1/79)

U.S. DEPARTMENT OF ENERGY

DOE AND MAJOR CONTRACTOR RECOMMENDATIONS FOR DISPOSITION OF SCIENTIFIC AND TECHNICAL DOCUMENT

See Instructions on Reverse Side

	2. Contract No.	3. Subject Category No.
HEDL-7450	DE-AC06-76FF0217	1
4. Title IRRADIATION OF COPPER	ALLOYS IN FFTF	F.A. Garner
5. Type of Document ("x" one) a. Scientific and technical report b. Conference paper: Title of conference		
	- 	Date of conference
Exact location of conference	Sponsoring organization	
c. Other (Specify Thesis, Translations, etc.)	CLEARED MISC. DOCUMENT	
S. Copies Transmitted ("x" one or more)		
a. Copies being transmitted for standard distrib	button by DOE-TIC.	
b. Copies being transmitted for special distribut		
Two completely legible, reproducible copies		
d. Twenty-seven copies being transmitted to 00	UE-FIC for FIC processing and NTIS sales.	
 Recommended distribution ("x" one) a. Normal handling (after patent clearance): no 	a samenam na distribution susant se mou be s	equired by the recurry absorbing on
Make available only b. to U.S. Government age	encies and their contractors.	a QOE and to QOE contractors.
☐ d. within DOE.	·	is listed in item 13 below.
t. Other (Specify)		
, Recommended Announcement ("x" one)		
a. Normal procedure may be followed.	\square b. Recommend the following announceme	nt limitations:
a. Preliminary information	eared primarily for internal use. 🔲 c. Of	ther (Explain)
R Patent Cleanance		
• • • • • • • • • • • • • • • • • • • •	uroment gracess or material?	¥ No
Ques this information product disclose any new equ		No luct? If so, identify the DOE (or atner)
•	E covering any aspect of this information prod	•
Odes this information product disclose any new equinates an invention disclosure been submitted to DDE	E covering any aspect of this information products submitted. Yes	uct? If so, identify the DOE (or ather) No
Opes this information product disclose any new equivalent to the disclosure been submitted to 00 E disclosure number and to whom the disclosure will have there any patent related objections to the release.	E covering any aspect of this information products submitted. Yes	uct? If so, identify the DOE (or ather) No ose objections.
Odes this information product disclose any new equivalent to information disclosure been submitted to 00 E disclosure number and to whom the disclosure was the same any patent related objections to the release. ("x" one) a. 00 E patent clearance has be b. 0 occument has been sent to riving the same of t	E covering any aspect of this information product as submitted. Yes asso of this information product? If so, state the sen granted by responsible DOE patent group, responsible DOE patent group for clearance, ment only, "x" one)	uct? If so, identify the DOE (or other) No ose objections.
Odes this information product disclose any new equivalent an invention disclosure been submitted to ODE disclosure number and to whom the disclosure was Are there any patent related objections to the release. ("x" one) a. ODE patent clearance has been sent to roughly be obtained to contain the containing of the con	E covering any aspect of this information product as submitted. Yes ass of this information product? If so, state the sen granted by responsible DOE patent group, responsible DOE patent group for clearance.	uct? If so, identify the DOE (or other) No ose objections.
Odes this information product disclose any new equivalent invention disclosure been submitted to ODE disclosure number and to whom the disclosure was Are there any patent related objections to the release. ("x" one) a. ODE patent clearance has be b. Document has been sent to risk to the related objections. National Security Information (For classified document and Document b. Document	Ecovering any aspect of this information product as submitted. Yes ass of this information product? If so, state the sen granted by responsible DOE patent group, responsible DOE patent group for clearance, ment only, "x" one) contain national security information other	uct? If so, identify the DOE (or other) No ose objections. than restricted data.
Odes this information product disclose any new equivalent invention disclosure been submitted to 00 E disclosure number and to whom the disclosure was Are there any patent related objections to the release. ("x" one) a. 00 E patent clearance has be b. 0 occument has been sent to risk in the control occument and 0 compared by does not copy Reproduction and 0 istribution.	Ecovering any aspect of this information product as submitted. Yes ass of this information product? If so, state the sen granted by responsible DOE patent group, responsible DOE patent group for clearance, ment only, "x" one) contain national security information other. Number of copies distributed outside origin	uct? If so, identify the DOE (or other) No ose objections. than restricted data.
Has an invention disclosure been submitted to 00E disclosure number and to whom the disclosure was Are there any patent related objections to the releasing to	Ecovering any aspect of this information product as submitted. Yes ass of this information product? If so, state the seen granted by responsible DOE patent group, responsible DOE patent group for clearance, ment only, "x" one) contain national security information other Number of copies distributed outside origin separate sheet, if necessary)	uct? If so, identify the DOE (or other) No ose objections. than restricted data.
Odes this information product disclose any new equivalent in invention disclosure been submitted to ODE disclosure number and to whom the disclosure with the there any patent related objections to the release. ("x" one) a. ODE patent clearance has been been sent to release by the control of the clearance has been sent to response to the release patent to response to the clearance has been sent to response to the release process to the release patent to response to the release patent to release patent to response to the release patent to release pate	Ecovering any aspect of this information product as submitted. Yes ass of this information product? If so, state this information product? If so, state this information product? If so, state this information of considerable OOE patent group, responsible OOE patent group for clearance. Interest only, "x" one) Contain national security information other Number of copies distributed outside origin separate sheet, if necessary)	ese objections.
Odes this information product disclose any new equivalent to the release of the control of the release of the control of the release of the r	Ecovering any aspect of this information product as submitted. Yes ass of this information product? If so, state this information product? If so, state this information product? If so, state this information of considerable OOE patent group, responsible OOE patent group for clearance. Interest only, "x" one) Contain national security information other Number of copies distributed outside origin separate sheet, if necessary)	ese objections.
Odes this information product disclose any new equivalent in the disclosure been submitted to ODE disclosure number and to whom the disclosure we have there any patent related objections to the release. ("x" one) a. DOE patent clearance has be b. Document has been sent to r. 1. National Security Information is For classified document a. does b. does not comment a. does b. does not capy Reproduction and Distribution total number of codies reproduced. 3. Additional Information or Remarks (Continue on s.) 4. Submitted by (Name and Position) (Please print or inisting Willingham, Clerk - [Inisting Willing Willingham]	Ecovering any aspect of this information product as submitted. Types Types Types Types Types Ecovering any aspect of this information product as submitted. Types Types	IND NO Than restricted data. ICROFILM SERVICES