

M. J. Sears

General Electric Company
KNOLLS ATOMIC POWER LABORATORY
Schenectady, New York

KAPL-M-KM-1

Metallurgy and Ceramics

A NEW TECHNIQUE FOR POLISHING AND ETCHING ZIRCALOY II AND U-Zr ALLOYS

by

K. Minassian

April 3, 1958

E. E. Baldwin
Authorized Classifier
April 3, 1958

Operated for the U.S. Atomic Energy Commission by the General Electric Company
Under Contract No. W-31-109 Eng. 52.

401 001

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

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

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

- a. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights, or
- b. Assumes any liabilities with respect to the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

DISTRIBUTION

NUMBER OF COPIES

RJ Allio	1
EE Baldwin	1
JA Baumgardner	1
AP Beard	1
CE Beck	1
AR Bibb, Jr.	1
CJ Bier	1
SM Bishop	1
EJ Callahan	1
LS DeLuca	1
T Dreier	1
JD Dunbar	1
AK Eikum	1
TF Fisher	1
RJ Enrico	1
JM Gerken	1
CE Galonian	1
P. Johnson	1
LD Kirkbride	1
C Krastins	1
FW Kunz	1
CE Lacy	1
PG Lozier	1
RF Lupi	1
LJ Martel	1
J Medel	1
RL Mehan	1
K Minassian	5
JN Mylroie	1
RF Nippes	1
FR Plant	1
HJ Plumbly	1
WE Seymour	1
RA Sierakaj	1
RC Townsend	1
W VanNatten	1
AC Ward	1
CE Weber	1
BD Wemple	1
DM White	1
JF Whitman	1
CJ Schmidt/TIG File	5
Document Library	3
HJ Sears	3
OF McKittrick	1

**DO NOT
PHOTOSTAT**

ABSTRACT

An investigation has been made of polishing and etching Zircaloy II and U-Zr alloys by automatic sanding and an etch-polish to obtain a highly polished surface. A micro-finish has to be obtained in order to use the etchant developed (30cc HNO_3 , 3cc HF, 30cc Lactic acid). Clearer structural definition of U-Zr alloy results from the use of this etchant, etch pits which are commonly observed in Zircaloy II and U-Zr alloys are also considerably reduced.

OBJECT

To make more efficient and effective metallographic examination of Zircaloy clad, U-Zr alloy fuel plates, an effort was made to devise a reproducible method for polishing and etching Zircaloy II and U-Zr alloys to improve structural definition. The standard polish used at KAPL is a chemical polish (45cc H_2O , 45cc HNO_3 , 10cc HF).

A recent etchant recommended was 30cc HNO_3 , 6 drops HF, 30cc Lactic Acid.⁽¹⁾ Although the latter was an improvement over the standard etchant, it was felt that a further investigation should be made in order to devise a new etchant.

PROCEDURE

The present method used to obtain a micro-finish on Zircaloy II and U-Zr alloys has been to polish each mount individually. This method is time consuming, whereas the method described herein is much simpler and quicker, since a number of samples can be simultaneously polished in an automatic polisher.

To date, no etchant has been used in the metallography of Zircaloy II and U-Zr alloys other than the HF etch-polish. The etch polish is used for bright field inspection only, and does not reveal structure under polarized light. The etchant described herein makes possible examination under both bright field and polarized illumination.

The Zircaloy specimens are mounted in Bakelite in a conventional manner. The rough polishing is accomplished by automatic grinding wheels using 240, 400 grit paper and 600 grit wet paper. The final polish is obtained with the

rough canvas (untreated drill cloth No. 60) using Linde-A powder followed by Linde-B powder on Gamal* cloth wet with 10% Oxalic Acid continuously and 1% HF solution intermittently. This method prevents cold working the surface and eliminates the majority of the scratches. To attain a better quality finish after automatic grinding, one can resort to polishing manually on the wet gamal cloth using Linde-B powder, 10% Oxalic acid and 1% HF solutions, with the mount held stationary with a positive pressure on the wheel and rotating the mount approximately 90° for a few minutes, until the surface is clean and fairly free of scratches. The etchant can be applied at this point with a cotton swab in a circular motion.

RESULTS

Figures 1 and 2 illustrate the improvement which results from application of the new polishing technique and etchant. While a chemical polish has a tendency to exaggerate or completely destroy fine detail, the new technique seems to eliminate these difficulties.

CONCLUSION

The etchant produces a cleaner surface and reduces etch pits which are mistakenly taken for inclusions. This etchant surpasses most of the conventional etchants presently used for Zircaloy and U-Zr. The grain boundaries are clearly defined in bright field examination and also by polarized light.

RECOMMENDATIONS

On the basis of results obtained, it is recommended that the polishing and etching technique outlined herein be instituted as an additional method of preparing metallographic samples of Zircaloy and U-Zr alloys as required.

REFERENCES

- (1) D. Douglas, L. L. Marsh, Jr., and G. K. Manning - Transformation Kinetics of Zirconium-Uranium Alloys - Transactions ASM, Vol. 50 - Preprint No. 20 - 1957
- *Fisher Scientific Co.

Chemical Polish - 45cc H₂O, 45cc HNO₃, 10cc HF

New Etch - 30cc HNO₃, 3cc HF, 30cc Lactic Acid



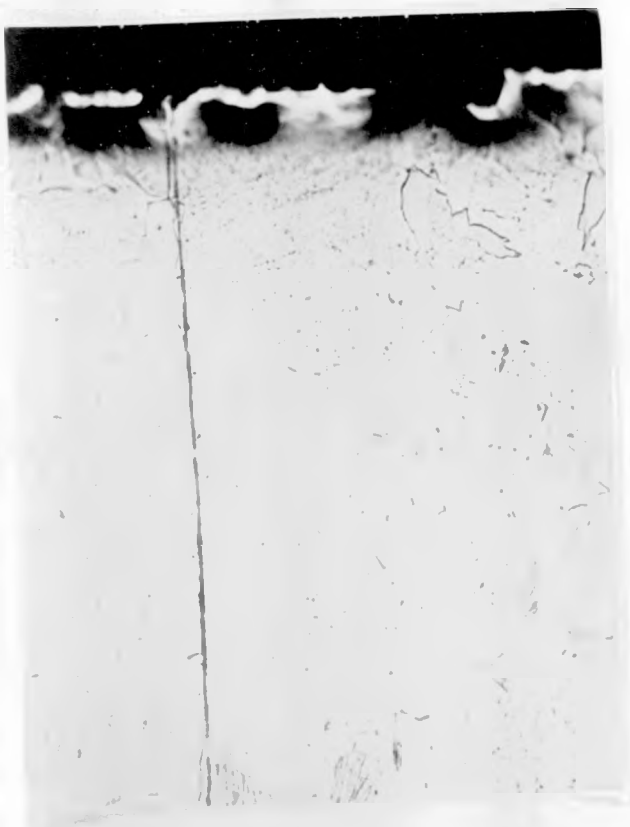
250X
Bright Field
Chemical Polish



250X
Bright Field
New Etch

KS-19463
UNCLASSIFIED

Figure 1



250X
Bright Field
Chemical Polish

Same Corner Area



250X
Bright Field
New Etch

Figure 2

KS-19464
UNCLASSIFIED

401 505