M J Sears

General Electric Company
KNOLLS ATOMIC POWER LABORATORY
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Metallurgy and Ceramics

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

by

K. Mirassian

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E. E. Baldwin
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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, 3ccHF, 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.

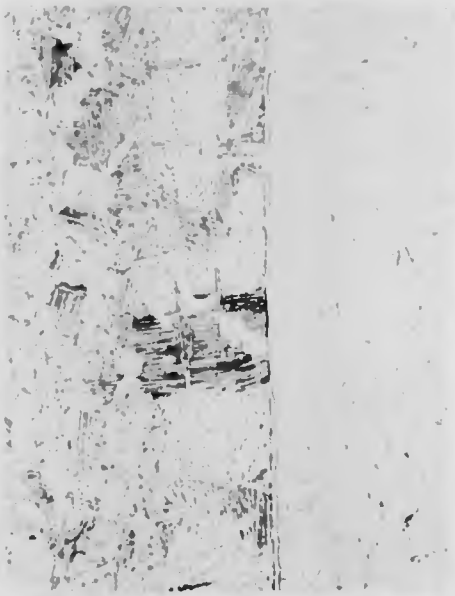
REFERENCES

(1) DL Douglas, LL Marsh, Jr., and GK Manning - Transformation Kinetics of Zirconium-Uranium Alloys - Transactions ASM, Vol. 50 - Preprint No. 20 - 1957

*Fisher Scientific Co.

Chemical Polish - 45cc H_2O, 45cc HNO_3, 10cc HF

New Etch - 30cc HNO_3, 3cc HF, 30cc Lactic Acid



250X
Bright Field
Chemical Polish

250X
Bright Field
New Etch

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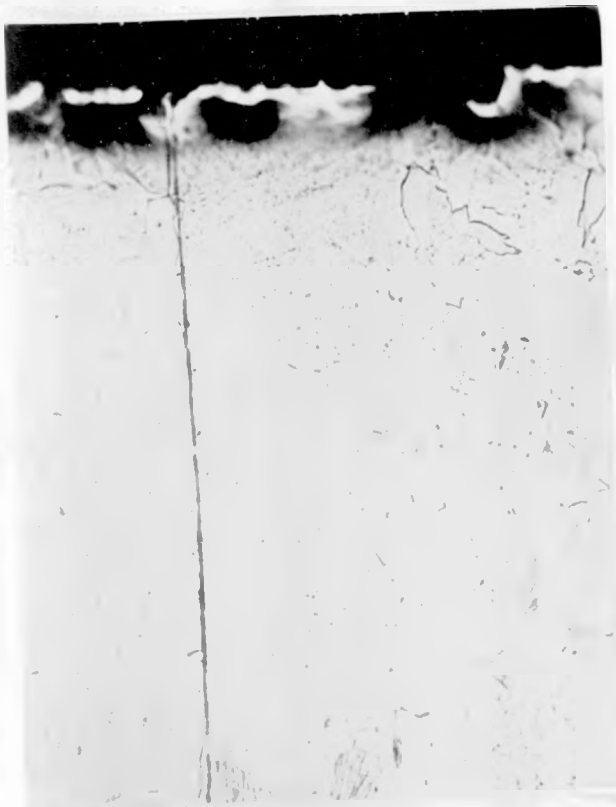
Figure 1



250X
Bright Field
Chemical Polish

Same Corner Area

250X
Bright Field
New Etch

Figure 2

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