1600 CD
DOI: 10.1017/S1431927606065135
Microsc Microanal 12(Supp 2), 2006

Metallographic Preparation Techniques for Uranium and Its Alloys

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Historically, metallographic preparation of uranium has utilized such techniques as chemical attack polishing and/or oxidation, electropolishing, electroetching, and anodizing. While these techniques define individual microstructural features, a more general technique (which can reveal all aspects of the microstructure simultaneously) has been lacking. An evaluation of the existing techniques provided the basis for modification and the subsequent development of a new metallographic technique. The objective was to find a technique which: (a) defines/resolves a broad array of microstructural characteristics, (b) retains inclusions, (c) can be universally applied to all uranium/uranium alloys with only slight (if any) modifications, (d) doesn't present a waste disposal problem, (e) can be mixed and stored easily, (f) is user friendly, and (g) reduces processing time.

Basic processing time is reduced when specimens are ground on 120 through 800 grit SiC grinding papers. The 800 grit grinding step eliminates the need for coarse polishing steps, and is followed by polishing on a low nap cloth using a 3μm diamond abrasive, 15N force, for approximately 10 minutes. The final polishing step is accomplished using a 1μm diamond abrasive on a napped cloth for approximately 3-5 minutes.

Specimens are electropolished using 3-4 V with a 5% H_3PO_4 aqueous solution for ~2-3 s, which in some instances is sufficient to produce the desired microstructural definition, as illustrated in figs. 1-3. Further definition of microstructural features is accomplished by electroetching in a 10% oxalic acid aqueous solution at 4-5V for ~ 3-5 s.

Illustrated in Fig.1 is a comparison of a specimen (a) in the as-mechanically polished and oxidized condition and (b) the advantages produced by electropolishing (a well-defined microstructure with less apparent scratches). The electropolishing process also provided sufficient definition to characterize the partially recrystallized microstructure shown in Fig.2.

The electropolish/electroetching sequence, seen in Fig.3, provides detailed information regarding inclusion dispersion, grain size and uniformity, and twinning.

Chemical banding in rolled a U 6.0 wt% Nb specimen is illustrated in Fig. 4. The specimen was electropolished, electroetched, and electropolished again to reveal not only grain boundaries and inclusions, but also segregation bands, which vary in color with chemical composition. The validity of the results was documented by a series of hardness data and chemical analysis via electron microprobe analysis.

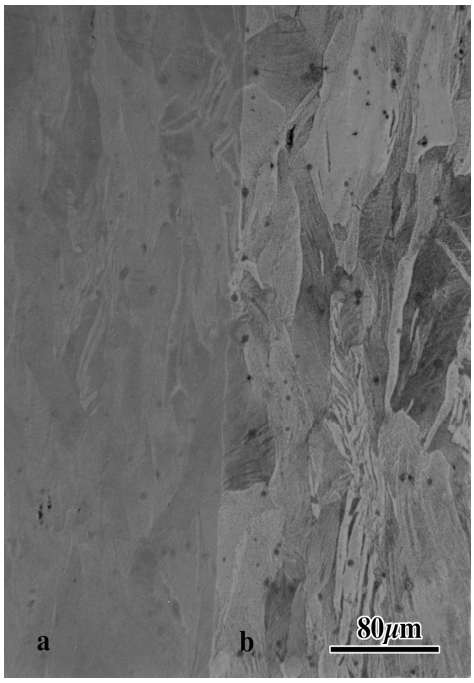

Fig 1.) Comparison of (a) a mechanical polished and oxidized surface and (b) an electro-polished surface.

Fig. 2) showing partially recrystallized structure in unalloyed uranium.

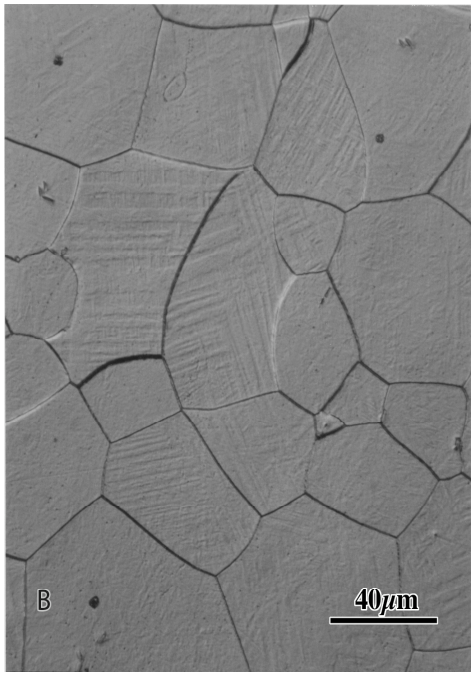

Fig.3 illustrates typical microstructure found in U 6.0Nb.

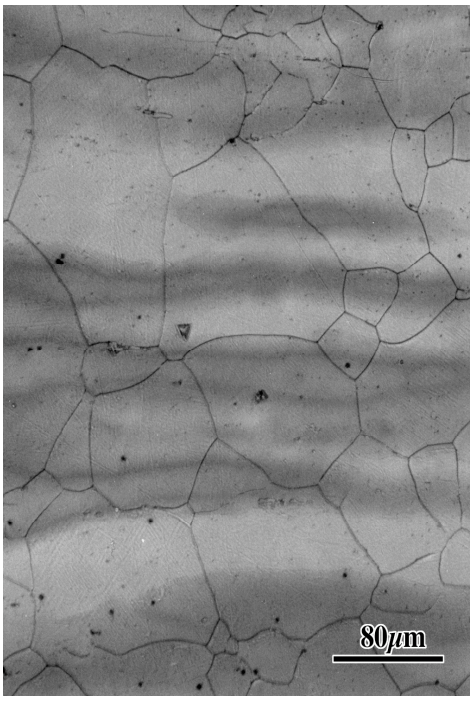

Fig. 4 shows chemical banding U-6.0 Nb after electro-polish, electro-etch, electro-polish sequence.

https://doi.org/10.1017/S1431927606065135 Published online by Cambridge University Press