4.6 ALLOYING AND NEUTRON IRRADIATION EFFECTS IN TUNGSTEN-RHENIUM - L.M. Garrison, L.L. Snead, E. Ohriner (Oak Ridge National Laboratory)

OBJECTIVE

The objective of this project is to gain a fundamental understanding of the changes to mechanical and thermal behavior of tungsten that are caused by neutron irradiation and rhenium additions.

SUMMARY

Five alloys of tungsten with different amounts of rhenium additions as well as one pure tungsten control material were fabricated by arc melting. After arc melting the samples were hot-rolled to approximately 80% reduction. Samples for mechanical testing, thermal testing, and neutron irradiation are being prepared from these alloys.

PROGRESS AND STATUS

Introduction

Rhenium additions to tungsten are known to change the thermal and mechanical properties. Because rhenium is produced by transmutation in neutron irradiated tungsten, any neutron irradiated sample of tungsten displays a combination of the irradiation induced structural changes as well as the changes caused by the rhenium. In order to separate and understand these two effects, samples of tungsten with varying amounts of rhenium were fabricated for thermal and mechanical testing before and after irradiation.

Results

The alloy compositions are listed in Table 1. After the initial arc-melting, the materials were brittle and had internal cracks and voids which made them difficult to machine. To improve the microstructure, the materials were hot-rolled at 1200°C to approximately 80% reduction. The rolling has been completed on all six alloys.

Table 1. W-Re alloy compositions.

Alloy number	Initial Re wt.%
Alloy 1	0.033
Alloy 2	0.165
Alloy 3	0.830
Alloy 4	3.440
Alloy 5	17.700
Alloy 6	0.000

Figure 1a shows the representative structure of the material after hot-rolling. After the rolling was completed, the materials' machinability had improved and samples were able to be cut and polished from the materials. Disk samples (Figure 1b) for neutron irradiation, thermal testing, and mechanical testing have been machined from Alloy 1 and Alloy 4. Alloys 2, 3, 5, and 6 are currently being prepared for machining.

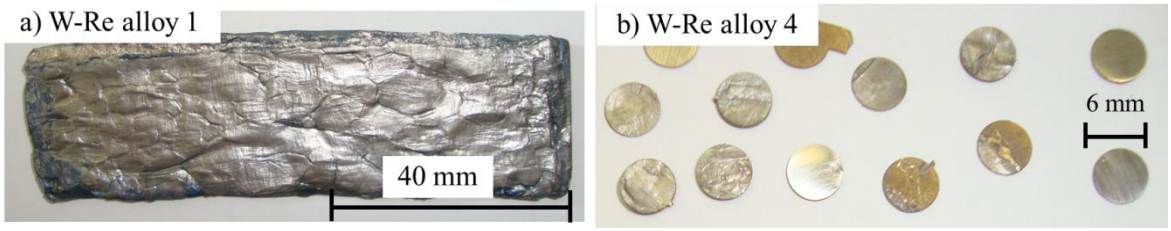

Figure 1. a) Tungsten-rhenium Alloy 1 (0.033 wt. % Re) after hot rolling. b) Alloy 4 (3.44 wt. % Re) disks cut from the rolled material in various stages of finish.

In the as-melted state, a sample of Alloy 4 was polished and examined in the SEM (Figure 2). It had large grains on the order of a few millimeters, and at some grain boundaries there was separation (Figure 2b). After rolling, a sample of W-Re Alloy 4 was mechanically polished down to a diamond paste and then finished with a colloidal silica solution (Figure 3). The texture visible in Figure 3 was apparent only after the silica polishing step, so may be the result of preferential chemical etching by the silica. Further metallographic analysis will be performed on the rolled alloys.

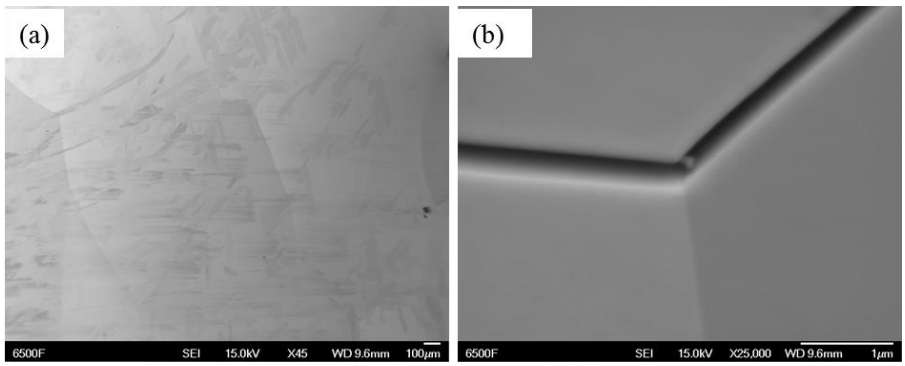

Figure 2. Tungsten Alloy 4 with ~3 wt. % rhenium in the as-melted state had (a) large grains on the order of ~0.5-2mm and (b) separation along some grain boundaries.

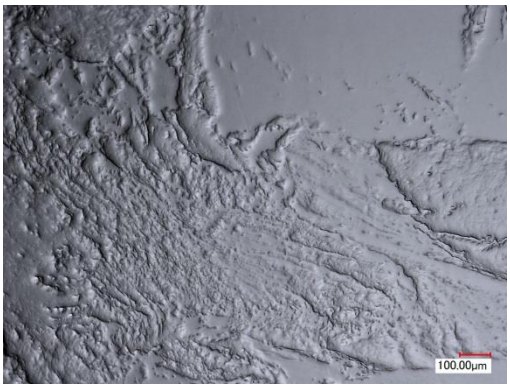

Figure 3. Alloy 4 after it was hot rolled and polished.