4.7 ALLOYING AND NEUTRON IRRADIATION EFFECTS IN TUNGSTEN-RHENIUM — L. M. Garrison (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 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 to improve the microstructure. The distribution of rhenium in one of the alloys was investigated with EDS. Samples for mechanical testing, thermal testing, and neutron irradiation are being prepared from these alloys.

PROGRESS AND STATUS

Introduction

Tungsten transmutes to rhenium during neutron irradiation. The behavior of the transmuted rhenium and its influence on the thermal and mechanical properties of tungsten needs to be better understood. The atoms displaced by the neutron irradiation also create defects that can change the thermal and mechanical properties of tungsten. To isolate and understand the influence of the rhenium versus the influence of the neutron damage, tungsten alloyed with varying amounts of rhenium will be evaluated before and after irradiation.

Results

The alloy compositions that were fabricated by arc-melting 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. During hot rolling, the materials were encased in molybdenum boxes. The molybdenum outer layer was then chemically dissolved from the sample materials.

Table 1. W-Re alloy compositions.

Alloy number	Initial Re wt.%
Alloy 1	0.03
Alloy 2	0.17
Alloy 3	0.83
Alloy 4	3.4
Alloy 5	17.7
Alloy 6	0.0

After rolling, the appearance of Alloy 3 with large flat grains is representative of all the materials except Alloy 5 which contains significantly more rhenium than the other alloys (Figure 1). Alloy 5 was not able to be rolled as thin as the other alloys and has smaller grains visible on the exterior than the other alloys.

Figure 1. Alloy 3, left, and Alloy 5, right, after rolling.

Alloy 4 with nominally 3.4% Re was analyzed with EDS to determine the distribution of Re in the sample. The qualitative map in Figure 2 shows the Re is present in the sample in concentrated areas rather than evenly distributed throughout. However, no second phase was identified with the EDS analysis.

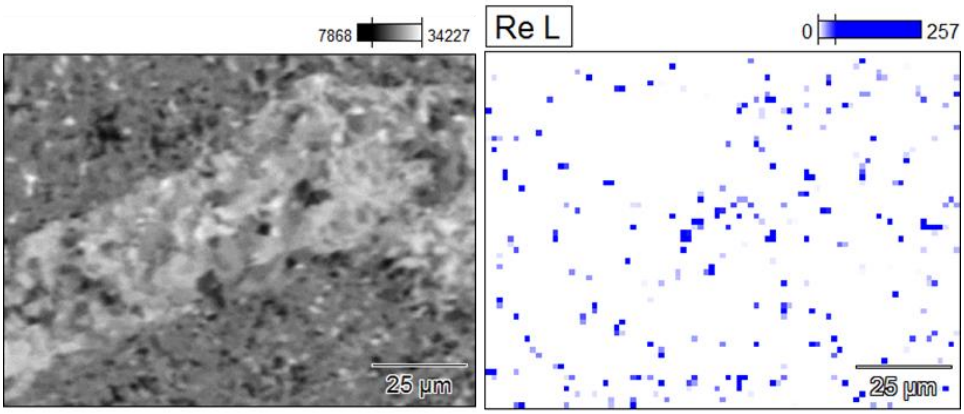

Figure 2. EDS qualitative elemental map of the W-3.4% Re sample showing the rhenium distribution.