NASA TECH BRIEF

Lower-Cost Tungsten–Rhenium Alloys

Applications of the refractory metal tungsten have been limited because of its very low ductility at room temperature. Although binary alloys of tungsten containing approximately 22 to 39 percent by weight of the scarce refractory metal rhenium are considerably more ductile than unalloyed tungsten, the high cost of rhenium has restricted the use of these alloys.

Further research has now shown that tungsten-rhenium alloys with a substantially more dilute rhenium content, 1.0 to 9.1 percent by weight, have ductilities and other mechanical properties which compare favorably with the tungsten–rhenium alloys having much higher concentrations of the costly rhenium. The considerably lower cost of the dilute tungsten–rhenium alloys should make them attractive for a wider range of applications than was practicable with unalloyed tungsten or the more concentrated tungsten–rhenium alloys.

Tungsten alloys containing 1.0 to 9.1 weight-percent rhenium were prepared by electron beam and arc melting, respectively. These were fabricated into sheet and/or rod and subjected to evaluation tests. A commercial arc melted 26-percent-rhenium alloy, an electron beam melted 24-percent-rhenium alloy, and unalloyed tungsten were also evaluated for comparison.

The dilute tungsten–rhenium alloys were significantly more ductile than unalloyed tungsten fabricated in a similar manner. Ductile–brittle bend transition temperatures of −75° and −100°F were observed for worked sheet of the electron beam melted alloys with 1.9 and 9.1 percent rhenium, respectively. The dilute arc melted alloys were slightly less ductile than the electron beam melted alloys, and room temperature ductility was observed only with the 1.0 percent rhenium alloy. These compared with transition temperatures of 215° and 235°F for worked sheet of unalloyed arc and electron beam melted tungsten, respectively. Transition temperatures for the arc-melted 26-percent-rhenium alloy and the electron-beam melted 24-percent-rhenium alloy were −150° and approximately −310°F, respectively.

Annealing at 3600°F recrystallized all the alloys and significantly increased the bend transition temperatures. Minima in transition temperature of 450° and 400°F occurred at 2 percent rhenium in the series of electron beam melted alloys and at approximately 4 percent rhenium in the arc melted alloys, respectively, compared with 630° to 670°F for unalloyed tungsten. The 24- and 26-percent-rhenium alloys, with transition temperatures of 375° and 350°F, respectively, were slightly more ductile than the best dilute alloys after this anneal.

At 2500° to 3500°F, the short time tensile strength increased with increasing rhenium up to 9.1 percent rhenium.

The creep strength at 3500°F increased with increasing rhenium content up to 5 to 7 percent rhenium. The 24- and 26-percent-rhenium alloys were weaker than the dilute alloys and had about the same creep strength as unalloyed tungsten.

Note:

Inquiries concerning this innovation may be directed to:

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(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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