December 1966 Brief 66-10551

NASA TECH BRIEF

New Tungsten Alloy Has High Strength at Elevated Temperatures

The problem:

To develop refractory alloys having high strength at temperatures above 2500° F.

The solution:

A tungsten–hafnium–carbon alloy with tensile strengths of 88,200 psi at 3000° F and 62,500 psi at 3500° F.

On the basis of approximately four years of study of solid-solution and carbide-strengthened, arc-melted tungsten alloys, efforts were concentrated on the tungsten–hafnium–carbon system. The strongest alloy, tungsten–0.20 atom percent hafnium–0.26 atom percent carbon, has tensile strengths of 88,200 and 62,500 psi in the worked condition at 3000° and 3500° F, respectively.

In the earlier work, it was shown that (1) the tensile and creep strengths of arc-melted tungsten at 2500° to 3500° F were increased in decreasing order of effectiveness by additions of hafnium, tantalum, columbium, and rhenium, and (2) additions of carbon to a nominally tunsten–1 atom percent columbium alloy resulted in a further increase in strength over that of the tungsten–columbium binary alloy, due to stabilization of the cold worked structure by carbide precipitates. The present study was aimed at exploring the tungsten–hafnium system in more detail and examining the properties of several ternary alloys containing the above mentioned elements. It was found that the effectiveness of solid-solution strengthening could be correlated with the difference in atom size between the solute and tungsten, with the larger differences promoting greater strengthening. Carbon additions to the alloys produced various degrees of strengthening, with the largest effect found in the tungsten–hafnium–carbon alloys. The differences in strength of the various carbide-strengthened alloys could be correlated with the carbide particle size, where the finest particle size (most strengthening) was observed in the tungsten–hafnium–carbon alloys.

Notes:

1. Additional studies are being made to evaluate the effects of hafnium–carbon ratio, total alloying content, and processing variables.
2. Possible industrial applications for these alloys would include electrical components such as switches and spark plugs, die materials for die-casting steels, and heating elements.
3. Additional information concerning this innovation is given in NASA TN D-3248, "Mechanical Properties of Solid-Solution and Carbide-Strengthened Arc-Melted Tungsten Alloys", by Peter L. Raffo and William D. Klopp, available from the Clearinghouse for Federal Scientific and Technical Information. Inquiries may also be directed to:
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   Reference: B66-10551

Patent status:

No patent action is contemplated by NASA.

Source: (Lewis-336)

Category 03