NASA TECH BRIEF

Lewis Research Center

High Strength Forgeable Tantalum Base Alloy

The Problem:

To improve the high temperature creep properties of existing tantalum base alloys while retaining their excellent fabrication and welding characteristics.

The Solution:

Increase the tungsten content of tantalum base alloy to the 12-15% level.

How It's Done:

A tantalum base alloy composed of Ta-8W-1Re-0.7Hf-0.025C (described in NASA Tech Brief 71-10010) was modified to a composition of Ta-12W-1Re-0.7Hf-0.025C. By increasing the tungsten content from 8 to 12% and maintaining the rhenium, hafnium and carbon at nominally 1%, 0.7% and 0.025%, respectively, a significant increase in high temperature creep strength was achieved. Solid solution strengthening is provided by the tungsten and rhenium while the carbon reacts with the matrix to form a dispersed carbide phase. The hafnium provides corrosion resistance to the alkali metal coolants and thermodynamic working fluids in the advanced space nuclear power systems in which this alloy is used. The modified alloy has the following tensile properties:

	Room Temperature	1588 K (2400°F)
0.2% Yield Strength	132.6 ksi	41.7 ksi
Ultimate Strength	140.9 ksi	58.0 ksi
% Elongation	21.8%	34.6%

This compares to a yield strength of 85 ksi at room temperature and 30 ksi at 1588 K (2400°F) for the unmodified alloy. Electron beam welds in the modified alloy are ductile at room temperature. The stress for 1% creep in 1000 hours is 32.5 ksi at 1366 K (2000°F) and is 12 ksi at 1588 K (2400°F). Comparatively, the well-known Cb-modified TZM molybdenum base alloy exhibits similar strength at 1422 K (2100°F) but at 1588 K (2400°F) its creep strength degrades to approximately 5 ksi for 1% elongation in 1000 hours.

Notes:

1. The tantalum base alloy Ta-8W-1Re-0.7Hf-0.025C (ASTAR-811C) is described in NASA Tech Brief 71-10010. Other tantalum base alloys are described in NASA Tech Brief 66-10558.
2. Further information is available in the following reports:

   NASA CR-120818 (N73-16562), Final Report -- Development of Advanced High Strength Tantalum Base Alloys, Phase I - Screening Investigation

   NASA CR-120931 (N75-16660), Final Report -- Development of Advanced High Strength Tantalum Base Alloys, Phase II - Scale-Up Investigation

   NASA CR-121096 (N73-17625), Final Report -- Development of Advanced High Strength Tantalum Base Alloys, Phase III - Influence of Metallurgical Condition on the Mechanical Properties of ASTAR-811C Sheet

   NASA CR-134606 (N75-13086), Process Development of Two High Strength Tantalum Base Alloys (ASTAR-1211C and ASTAR-1511C)

   Copies may be obtained at cost from:
   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B75-10023
3. Specific technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B75-10023

(continued overleaf)

Patent Status:
NASA has decided not to apply for a patent.

Source: R. William Buckman, Jr.
Westinghouse Electric Corp.
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