NASA TECH BRIEF

Tantalum Alloys Resist Creep Deformation at Elevated Temperatures

The problem:

To develop refractory metal alloys possessing high strength and good resistance to creep deformation at elevated temperatures in high vacuum environments. Other properties required of the alloys are ease of fabrication, good weldability, and corrosion resistance to molten alkali metals.

The solution:

Dispersion-strengthened (precipitation-hardened) tantalum-base alloys containing a dispersed second phase comprised of carbides and/or nitrides which serve to pin dislocations and thus greatly improve the resistance of the alloys to creep deformation. Strengthening of the tantalum is achieved by solid-solution strengtheners consisting of tungsten, molybdenum, and rhenium, and also by the presence of stable precipitates resulting from the interaction of the metal additives hafnium and zirconium with nitrogen and/or carbon.

More specifically, the alloys include, in addition to tantalum, the element tungsten and some or all of the elements molybdenum, rhenium, hafnium, zirconium, carbon, and nitrogen. The composition range for these alloys in weight percent is as follows: tungsten, 7-10; zirconium, 0.25-0.6; nitrogen, 0.04-0.1; and tantalum, balance. Up to 1 percent by weight of molybdenum and/or 2-atom-percent rhenium may be substituted for the tungsten, part or all of the zirconium may be replaced with hafnium, and carbon (0.015-0.04 percent) may be substituted for nitrogen. Impurities should be maintained at a low level; the amount of oxygen must be restricted to less than 100 parts per million. Compositions within the given range should have an atom ratio of zirconium to nitrogen maintained at approximately unity for optimum resistance to creep deformation.

Notes:

1. The new tantalum-base alloys are significantly superior to T-222, the highest strength commercially available tantalum-base alloy.
2. Specific compositions have excellent room temperature ductility, which enables their cold rolling to sheet form.
3. The alloys have immediate applications such as in the highly stressed rotating turbine components of advanced space (high vacuum) power systems of the nuclear turbogenerator type. Possible nonaerospace applications for these alloys are structural materials for fluid flow components in chemical processing and nuclear reactor equipment.
4. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B66-10558

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: R. W. Buckman, Jr.
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Category 03