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NASA TECH BRIEF

Mechanism and Kinetics of Aging in Inconel 718

Inconel 718 is a nickel-chromium-iron-molybdenum alloy, hardened by the addition of columbium, tantalum, aluminum, and titanium. It is an age-hardenable superalloy with good high-temperature strength and a rather sluggish aging response. The low rate of precipitation hardening exhibited during aging is a major factor in giving this alloy good weldability. Its property of slow aging facilitates studies concerned with the precipitation process.

Age hardening in Inconel 718 was investigated using Brinell hardness measurements. Aging isotherms were determined at temperatures of 1141°, 1252°, 1314°, 1390°, and 1492°F. On aging at the three lowest temperatures, the hardness increased to a maximum and then remained constant. The aging time to reach maximum hardness was over 1000 hr at 1141°F, about 200 hr at 1252°F, and only 35 hr at 1314°F. At 1390° and 1492°F the hardness increased to a maximum within a few hours, then decreased. Maximum hardness was lower and aging time to reach maximum hardness was longer at 1492°F than at 1390°F.

The formation of a precipitate, identified as columbium-rich γ', Ni_3 (Cb, Al, Ti), causes an increase in hardness. The precipitate has a face-centered cubic structure, and forms coherently with the matrix during aging.

An aging mechanism was proposed whereby the observed changes in hardness below about 1340°F were associated with the formation and loss (by overaging) of the γ' phase. An activation energy of 76,500 calories per mole was determined for the growth of γ'.

There is an incubation period before Inconel 718 increases in hardness. The shortest incubation period corresponds to the fastest nucleation rate of the coherent γ' phase and occurs at approximately 1340°F.

Notes:

1. This information maybe of value in the formulation of new alloys using aging mechanisms.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: TSP70-10261

Patent status:

No patent action is contemplated by NASA.

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