View metadata, citation and similar papers at core.ac.uk

June 1970

Brief 70-10261

NASA TECH BRIEF



NASA Tech Briefs announce new technology derived from the U.S. space program. They are issued to encourage commercial application. Tech Briefs are available on a subscription basis from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151. Requests for individual copies or questions relating to the Tech Brief program may be directed to the Technology Utilization Division, NASA, Code UT, Washington, D.C. 20546.

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-nardenable 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' , Ni₃ (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.

Source: B. G. Koepke, R. J. Zeto, and W. E. Hensley of North American Rockwell Corporation under contract to Marshall Space Flight Center (MFS-18775)

Category 04

This document was prepared under the sponsorship of the National Aeronautics and Space Administration. Neither the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document, or warrants that such use will be free from privately owned rights.