NASA TECH BRIEF

Tensile and Fatigue Properties of Inconel 718 at Cryogenic Temperatures

A study has been made to determine the tensile and fatigue properties of Inconel 718 at cryogenic temperatures. Tensile and fatigue data were not available prior to this study, although the alloy has been used in cryogenic applications.

Inconel 718, a nickel-base alloy developed for use at high temperatures, has found use in many liquid-propellant rocket engine components because of its corrosion resistance, weldability, high strength, and toughness at cryogenic temperatures. Other examples of its present use at cryogenic temperatures include bellows and high-pressure ducting made from sheet stock, thrust-chamber jackets and pressure-actuated seals made from plate stock, high-strength bolts made from bar stock, and injectors made from large forgings.

The tensile properties, notch strength, and impact strength of a large forging in the longitudinal and transverse directions were determined at room temperature, −110°F, −320°F, and −423°F. Two heat treatments are compared: the 1950°F solution anneal plus 1400° to 1200°F aging, and 1800°F solution anneal plus 1325° to 1150°F aging. These tests show that the alloy increases in strength at low temperatures, with very little change in toughness.

The flexural reverse bending fatigue strength of sheet, the rotating beam fatigue strength of bar, and the axial loading fatigue strength of bar were determined for material in the 1950°F solution anneal plus 1400° to 1200°F age-heat-treat condition. Fatigue tests were run at room temperature, −320°F, and −423°F in the range of 10^4 to 10^7 cycles. The effect of surface finish and grain size on the fatigue properties was also determined. The fatigue strength increased significantly as the test temperature decreased, and the smooth finish showed higher fatigue strength than the rough finish. Fine-grained material showed higher fatigue strength than coarse-grained material.

Electron fractography examination of fracture surface caused by cyclic or repetitive loading was utilized for comparison of high-stress, low-cycle fatigue failures with low-stress, high-cycle fatigue failures. Fractographs illustrating typical flexural reverse bending, axial loading, and rotating beam failures at 70°F and cryogenic temperatures were made.

Note:

Documentation is available from:
Clearinghouse for Federal Scientific and Technical Information
Springfield, Virginia 22151
Price $3.00
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Patent status:

No patent action is contemplated by NASA.

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