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NASA TECH BRIEF

Lewis Research Center

High Strength Alloy for Intermediate Temperature, 24 to 704°C (75 to 1300°F), Applications

Further increases in the strength of conventional wrought superalloys are inherently limited, because segregation of alloying constituents which occurs during solidification from the melt prevents the use of strong, highly alloyed compositions. However, prealloyed powder compacts, despite their high alloy content, can be superplastically shaped by isothermal pressing or can be extruded into bars.

A significant breakthrough has been made in showing the potential of highly alloyed normally cast superalloys for achieving superior properties at intermediate temperatures. This was accomplished by applying prealloyed powder technology to the NASA-TRW-VI-A alloy, one of the most highly alloyed and also one of the strongest case nickel-base superalloys available today. This high-temperature alloy, which cannot be worked by conventional forging techniques, was transformed by powder metallurgy techniques into a workable, ultrahigh strength alloy for use at intermediate temperatures, i.e., from room temperature to 704°C (1300°F). The strength properties of the as-extruded prealloyed powder product can be further enhanced at intermediate temperatures up to 704°C (1300°F) by conventional heat treatments and at high temperatures, 982°C (1800°F), by autoclave heat treatments.

The NASA-TRW-VI-A alloy made by prealloyed powder techniques has a similar chemistry, but a totally different microstructure than its cast counterpart. The microstructure results in a material that has greatly improved low and intermediate temperature strengths and yet is very ductile at high temperatures, and this is readily workable by hot pressing at controlled strain rates. At room temperature, the ultimate tensile strength of the powder product was 1894 MN/m^2 (274,500 psi) and at 650°C (1200°F) it was 1628 MN/m^2 (236,000 psi), as compared with 1049 MN/m^2 (152,000 psi) and 1139 MN/m^2 (165,000 psi), respectively, for the as-cast counterpart. At 650°C (1200°F) and a stress of 1035 MN/m^2 (150,000 psi), the as-extruded VI-A powder product had a stress rupture life of 618 hours compared to 100 hours for the strongest conventionally-wrought alloy. An even greater improvement was achieved by utilizing an appropriate heat treatment which increased the life to 2013 hours. Use temperatures beyond 815°C (1500°F) are possible with the autoclave heat treated powder product. Its stress rupture life at 815°C (1500°F) is greater than, and at 980°C (1800°F) is competitive with, the strongest conventionally-wrought materials.

Notes:

1. Potential applications for this prealloyed powder NASA-TRW-VI-A alloy include: (a) turbine disks, (b) compressor disks and blades, and (c) any structural engineering application requiring outstanding strength up to intermediate temperatures as well as good workability.
2. The following documentation may be obtained from:
   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference: NASA TN-D-6560 (N72-10459), Applications of Powder Metallurgy to an Advanced-Temperature Nickel-Base Alloy, NASA-TRW-VI-A
3. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B72-10344

(continued overleaf)

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Mail Stop 500-311
Lewis Research Center
21000 Brookpark Road
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