NASA TECH BRIEF

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High Strength, Superplastic Superalloy

A high strength superplastic superalloy produced by extruding pre-alloyed powder has recently been developed at the NASA Lewis Research Center. The NASA TAZ-8A cast nickel base superalloy (nominal composition in weight percent: 6 aluminum, 6 chromium, 4 tungsten, 4 molybdenum, 2.5 columbium, 1 vanadium, 1 zirconium, 0.125 carbon, 0.004 boron and balance nickel) (see NASA Tech Brief 68-10094) was remelted and converted to pre-alloyed powder by inert gas atomization. The powder was then extruded into bar stock and evaluated both in the as-extruded form and after various heat treatments. (A commercially available alloy, INCO 713C was similarly processed for data comparison purposes.)

Tensile test specimens machined from extruded pre-alloyed TAZ-8A powder showed very high tensile strengths, e.g., room temperature and 1400°F ultimates of 228,000 and 164,000 psi, respectively. These values are higher than those obtained with any known cast or wrought nickel base alloy, and are about 1-1/2 to 2 times greater than for as-cast TAZ-8A.

The material also exhibits superplastic behavior at high temperature, e.g., neck-free elongations greater than 450% at 1800°F and 600% at 1900°F. This superplastic property (extremely high ductility) can be used to advantage in forming the alloy into an endless variety of configurations. By applying low strain rates and very low deforming loads while the material is held at high temperature, the alloy's superplastic behavior allows it to be readily shaped at very low processing cost. The superplastic properties can subsequently be removed by heat treating. The fact that superplasticity can be achieved with this alloy by means of the pre-alloyed powder technique and that it can be effectively utilized in forming operations contributes to the attractiveness of the alloy for expanded commercial use.

The use of pre-alloyed powders as a means of overcoming the problems inherent in conventional casting and hot working operations of superalloys has received considerable attention in the past few years. The specific technique used here involves atomization of the molten alloy with inert gas jets. Each metal droplet so formed solidifies rapidly and a highly homogeneous structure is obtained both in the powder particles, and in the final compacted product. Also, the extruded powder product has an extremely fine grain size (on the order of microns). This new processing development is also significant in that it provides a readily usable technique for achieving substantially higher strength, formable superalloys. Since micro- and macrosegregation are virtually eliminated in the final product, it becomes possible to formulate alloy compositions with higher quantities of strengthening alloying constituents than can be accommodated by conventional casting and wrought processing techniques.

Notes:

1. Immediate uses include engineering applications which require materials with substantially increased strength in the intermediate temperature range (room temperature to 1400°F), such as the disks and airfoils of the latter stages of compressors of advanced engines. Potential uses include engineering applications which require high strength nickel-base alloys formed to particular configurations.
2. Documentation is available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10293

(continued overleaf)

3. Technical questions may be directed to:
Technology Utilization Officer
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135
Reference: B69-10293

Patent status:

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

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