Microstructure, Mechanical Properties, Hot-Die Forming, and Joining of 47XD Gamma TiAl Rolled Sheets

G. DAS

Pratt & Whitney
P.O. Box 109600
West Palm Beach, FL 33410-9600 USA
Phone: 561-796-6744
Fax: 561-796-7454
E-mail: dasgopal@pwfl.com

S. Draper, J.D. Whittenberger, and P.A. Bartolotta
Glenn Research Center
2100 Brookpark Road
Cleveland, OH 44135-3191 USA
Phone: 216-433-3257 (Draper); 216-433-3196 (Whittenberger); 216-433-3338 (Bartolotta)
Fax: 216-433-8000
E-mail: Susan.L.Draper@lerc.nasa.gov; John.D.Whittenberger@lerc.nasa.gov;
Paul.A.Bartolotta@lerc.nasa.gov

The microstructure and mechanical properties, along with the hot-die forming and joining of Ti-47Al-2Nb-2Mn-0.8 vol% TiB_2 sheets (known as 47XD), produced by a low-cost rolling process, were evaluated. A near-gamma microstructure was obtained in the as-rolled condition. The microstructures of heat-treated sheets ranged from a recrystallized equiaxed near-gamma microstructure at 1,200 to 1,310 °C, to a duplex microstructure at 1,350 °C, to a fully lamellar microstructure at 1,376 °C. Tensile behavior was determined for unidirectionally rolled and cross-rolled sheets for room temperature (RT) to 816 °C. Yield stress decreased gradually with increasing deformation temperature up to 704 °C; above 704 °C, it declined rapidly. Ultimate tensile strength exhibited a gradual decrease up to 537 °C before peaking at 704 °C, followed by a rapid decline at 816 °C. The modulus showed a gradual decrease with temperature, reaching ~72 percent of the RT value at 816 °C. Strain to failure increased slowly from RT to 537 °C; between 537 °C and 704 °C, it exhibited a phenomenal increase, suggesting that the ductile-brittle transition temperature was below 704 °C. Fracture mode changed from transgranular fracture at low temperature, to a mixture of transgranular and intergranular fracture at intermediate temperature, to ductile fracture at 816 °C, coupled with dynamic recrystallization at large strains. Creep rupture response was evaluated between 649 and 816 °C over the stress range of 69 to 276 MPa. Deformation parameters for steady-state creep rate and time-to-rupture were similar: activation energies of ~350 kJ/mol and stress exponents of ~4.5. Hot-die forming of sheets into corrugations was done at elevated temperatures in vacuum. The process parameters to join sheets by diffusion bonding and brazing with TiCuNi 70 filler alloy were optimized for test coupons and successfully used to fabricate large truss-core and honeycomb structures. Nondestructive evaluation methods, *e.g.,* ultrasonic C-scans and thermography along with metallography, were used to characterize bond quality. Microstructural evaluation during heat treatment, identification of phases at the braze/matrix interface, determination of shear strengths of brazed joints, and deformation mechanisms during tensile and creep processes will be discussed.