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Creep and dimensional stability of high purity niobium electron beam weld

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The 5.6 mm wide EB weld shows grain boundaries on the left side and solidification ridges on the right side.

Fracture of weld specimen

Stress-Strain of weld and parent material

• E Beam Welds have equiaxed microstructure with 1 mm grain size in the fusion zone, ~100 μm in the heat affected zone (HAZ), and 50 μm in the parent metal.

• No room temperature creep occurs in normal specimen near yield strength level, but pronounced room temperature creep occurs in weld specimen at 72% yield strength (37MPa)

Creep deformation was not smooth or continuous; strain saturated at some value, and then restarted after an incubation time

An initial prestrain with a load release can shut down the creep deformation mechanism due to a dislocation locking effect

The creep deformation behavior was highly dependent on both the actual microstructure and loading history

An elastic FEM simulation of a portion of the weld fusion zone microstructure indicated that local stresses arise from anisotropic elastic interactions due to different crystal orientations, causing local stress concentration that exceeded the yield strength.

Three Weld Creep specimens (Transverse Direction)
1. Loaded directly to 45 MPa ε=0.02 2 hr
2. Loaded / Unloaded 37-43 MPa ε=0.008 600 hr
3. Step Loaded 37-45 MPa ε=0.02 800 hr

HAZ OIM Map show big grain size and misorientation

Elastic stress anisotropic calculated by FEM using left model, stress varies by a factor of 3

Color denotes the crystal direction pointing in the Normal Direction

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