Creep and dimensional stability of high purity niobium electron beam weld

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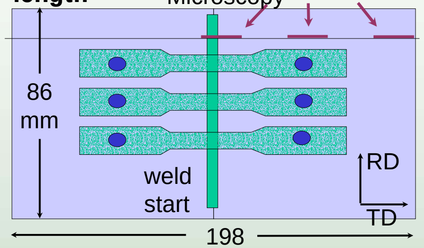
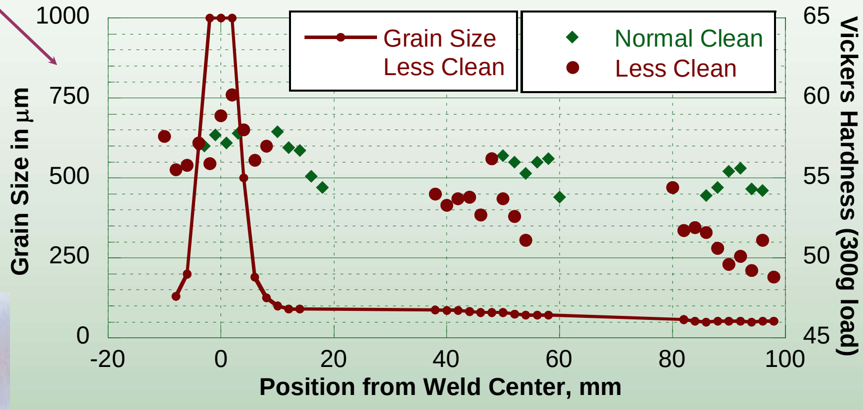
Weld creep specimens EDM'd from 2 mm sheet, 31 mm gage length



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

Grain size and Vickers Microhardness.



- 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)

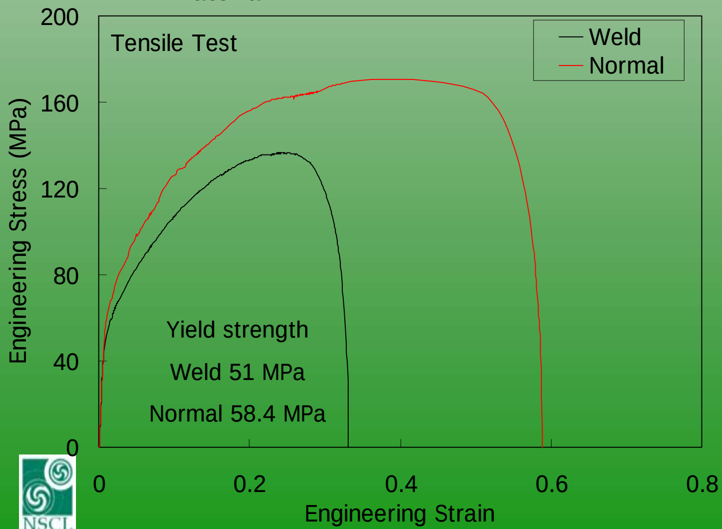
➢ Creep deformation was not smooth or continuous; strain saturated at some value, and then restarted after an incubation time

➢ 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

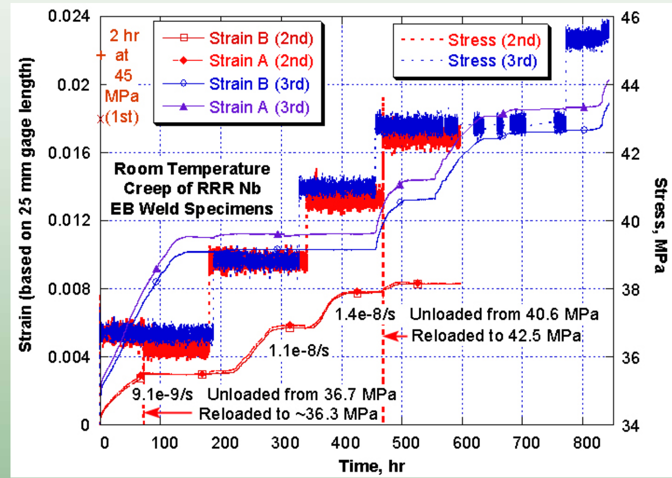
➢ An elastic FEM simulation of a portion of the weld fusion zone microstructure indicated that local stresses arise from anisotropic elastic interactions due to different crystal orientations, causing local stress concentration that exceeded the yield strength

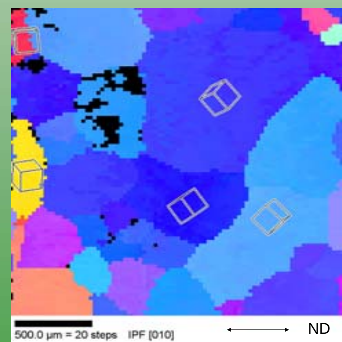
Stress-Strain of weld and parent material



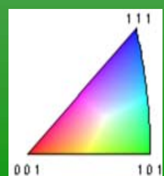
Three Weld Creep specimens (Transverse Direction)

1. Loaded directly to 45 MPa $\varepsilon=0.02$ 2 hr
2. Loaded / Unloaded 37- 43 MPa $\varepsilon=0.008$ 600 hr
3. Step Loaded 37- 45 MPa $\varepsilon = 0.02$ 800 hr

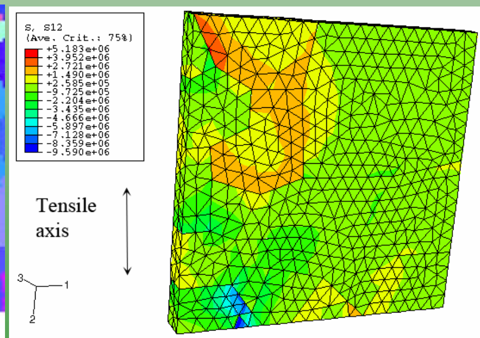




HAZ OIM Map show big grain size and misorientation



Color denotes the crystal direction pointing in the Normal Direction



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

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