Fabrication of Creep Tubing for JUPITER II Irradiation Experiments

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6th IEA and JUPITER Joint Workshop on Vanadium Alloys for Fusion Energy Applications

Tucson, Arizona (USA)
June 21 - 22, 2002

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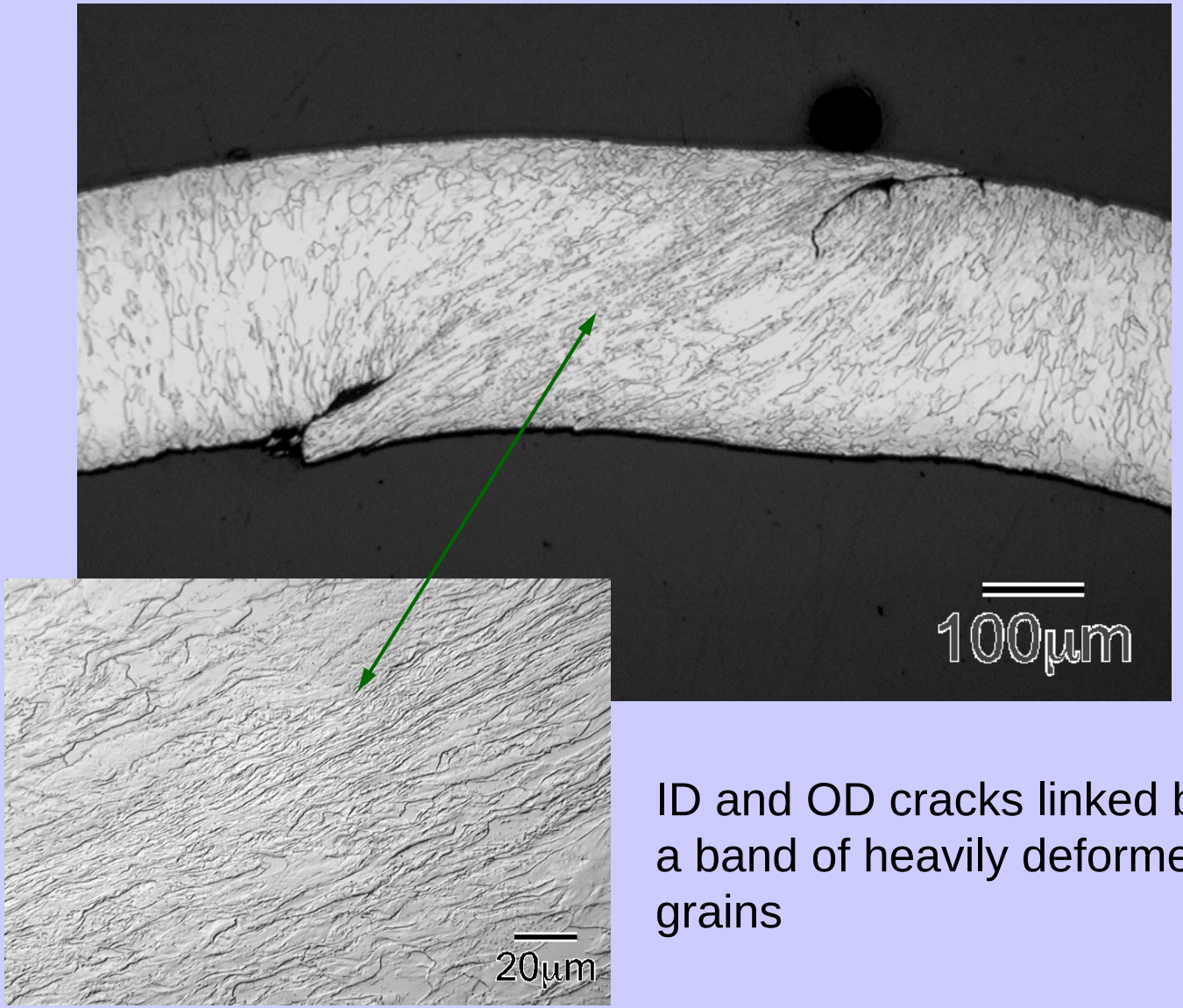
- Previous batch of creep tubing from Heat 836625 contained ID and OD cracks (10-200μm deep) frequently linked by a band of heavily deformed grains running at 45 degrees to the through-wall radial direction

- Possible factors involved in cracking;
  - oxygen pick-up during annealing (300 to 600 wppm)
  - compression of initial banded Ti(OCN) microstructure during tube reduction
  - carbon pick-up due to inadequate cleaning procedures (80 to 300 wppm)
  - reduction in area too high (45%) in final stages

Cracks Observed in Creep Tubing from Heat 836625



ID and OD cracks linked by a band of heavily deformed grains

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- Similar cracking problems developed during fabrication of creep tubing from NIFS-HEAT-2 [T. Nagasawa, T. Moroga, San Diego, April 2, 2000]

- Possible factors involved in cracking;
  - oxygen pick-up during annealing (124 to 300 wppm)
  - development of wavy banded structure related to non-uniform distribution of Ti(OCN) particles
  - reduction in area per cycle too high (45%)

Production of New Tubing for JUPITER II Experiments

- Production of ~800cm batches of tubing (4.57mm OD, 0.25mm wall) from NIFS-HEAT-2 and US heat 836625 is in progress at Century Tubes, San Diego using revised Technical Specification designed to avoid cracking problems

- Improved annealing/cleaning procedures;
  - 3 stage cleaning (Alconox-acetone-alcohol) followed by acid cleaning (nitric/hydrofluouric)
  - furnace bake-out at annealing temperature
  - Ta foil wrap; controlled heating rate with a 1 hr hold at 525°C for out-gassing
  - vacuum never to exceed 2×10^{-5} torr; 1000°C for 1 hr anneals

- Improved drawing procedures;
  - gun-drilling followed by honing ID to surface finish of 16 rms or better
  - drawing with successively smaller mandrels instead of sinking operations
  - reduction in area limited to 30-35% per cycle
  - inspection at each stage to include hardness, metallography and interstitial analysis

Projected Schedule

- Revised Technical Specifications and placement of purchase orders completed.....05/30/02

- Gun-drilling/honing tube blanks for both heats completed.....06/06/02

- Projected completion of finished tubing from both heats.....08/17/02