Formation of Banded Microstructure in V-4Cr-4Ti

D.T. Hoelzer and A.F. Rowcliffe

Metals and Ceramics Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831

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

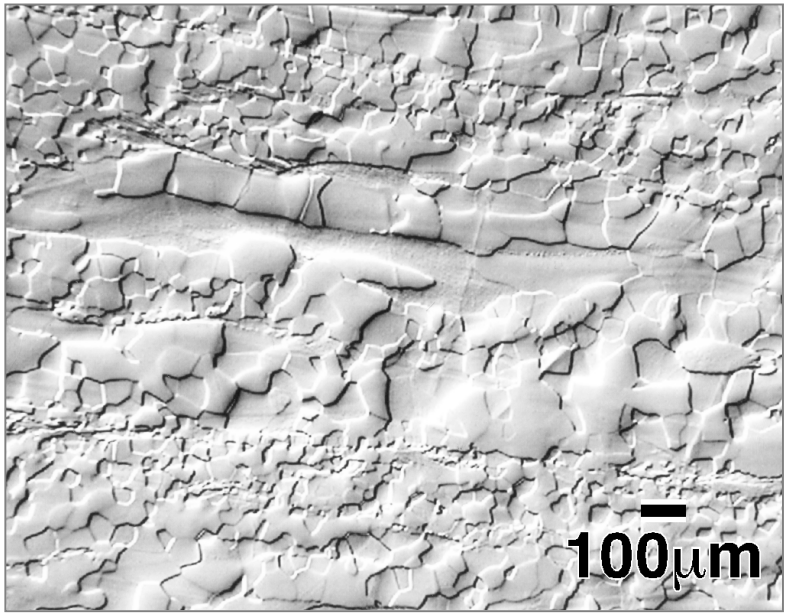
Tucson, Arizona (USA)
June 21 - 22, 2002

Banded Microstructures in V-4Cr-4Ti Alloys

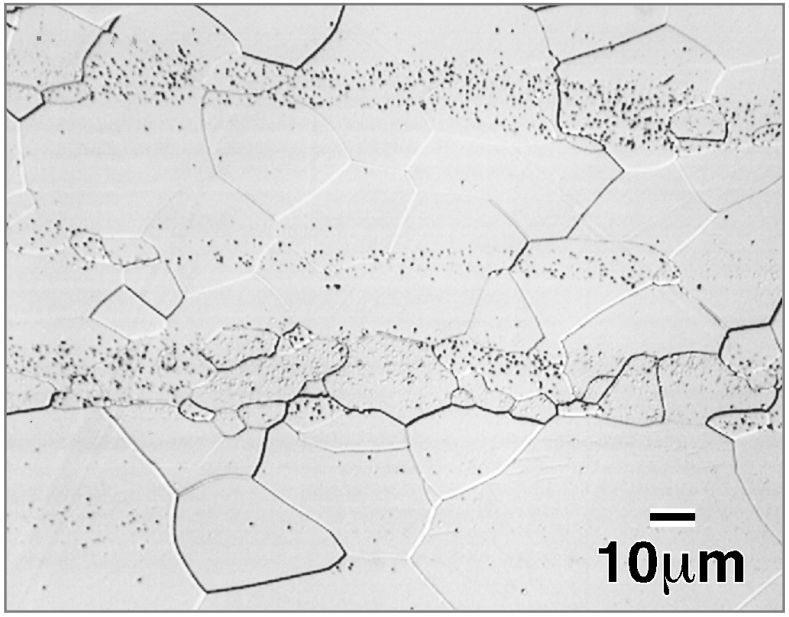
- Phenomena observed in U.S. Heats and NIFS-Heat-1
  - lower interstitial content of NIFS-Heat-1 may have minor effect
- Focus on factors that affect Ti(OCN) formation
  - thermomechanical processing temperature
    - depends on solvus temperature for Ti(OCN)
  - interstitial concentration
  - solute segregationeffects

Formation of Banded Grain Structure

Extruded at 1130°-1150°C



TMP and Annealed 1100°C/2h

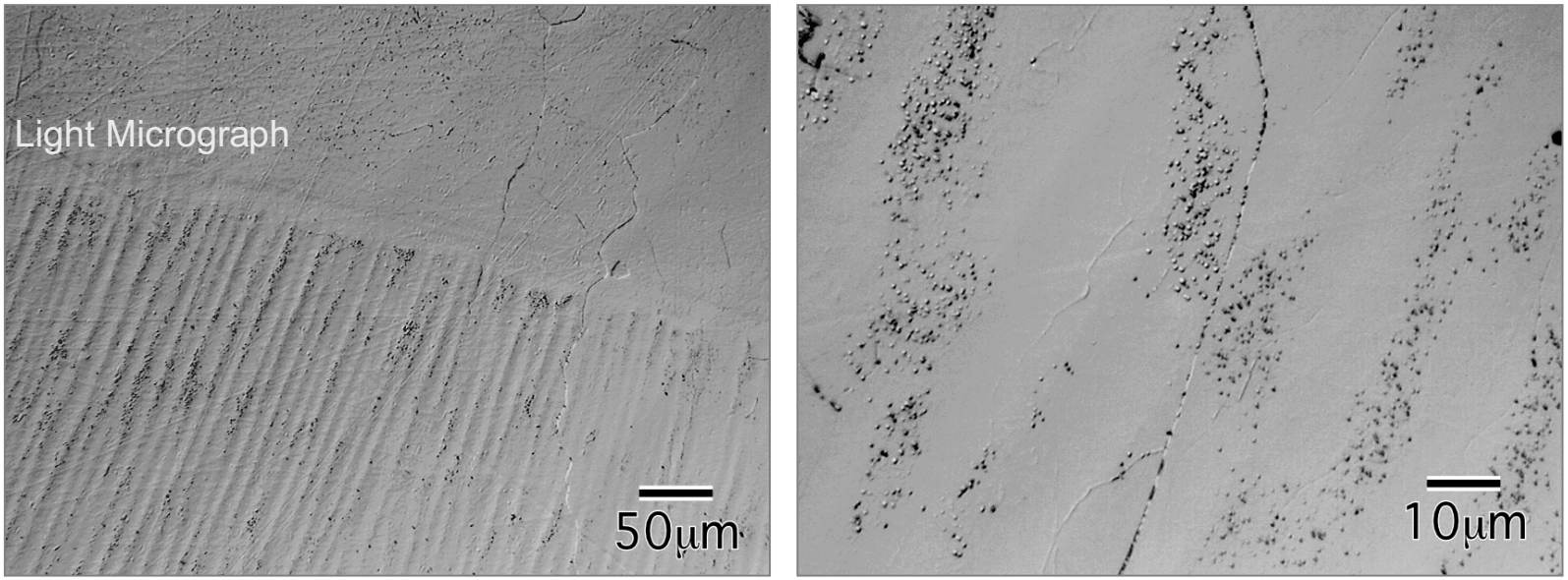


- Anisotropic microstructure develops during hot extrusion
  - dynamic recovery and recrystallized processes result in regions consisting of fine equiaxed and large elongated grains
  - no primary Ti(OCN) visible (LM)
- Non-uniform grain size and precipitate distribution develops during thermomechanical processing (TMP) and final recrystallization anneal

Recent Focus is on Segregation of Solute Atoms

Isochronal annealing from RT to 1200°C

(1hr at either 50°C or 100°C increments - 14 total)



- Evidence suggests that Ti segregates during solidification in GTA weld fusion zone
  - globular Ti(OCN) forms preferentially in Ti-rich regions during the isochronal annealings
- Also, from microprobe analysis of ingots prepared in RF
  - composition modulations in Ti; λ = ~55μm *(M.M. Potapenko et al. 1999)*

Current View on Formation of Banded Microstructure

(plate fabricated from the U.S. 500kg Heat of V-4Cr-4Ti)

- **Ingot**
  - Ti segregation during solidification
- **Hot extrusion at 1130°C to 1150°C**
  - inhomogeneities in deformation rate and temperature influence dynamic recovery and recrystallization processes
  - primary Ti(OCN) will likely be distributed non-homogeneously
    (1) localized regions with large undercooling
    (2) regions of high dislocation densities
- **Sequence of warm rolling (400°C) and annealing (1050°C) steps**
  - deformation structure influenced by Ti(OCN) distribution during rolling
  - recrystallization and further precipitation occur during annealing
  - non-homogeneities in Ti(OCN) distribution leads to non-uniform grain growth, resulting in the *banded microstructure*