Carburizing Heat Treat of Axial and Bending Fatigue Samples (Project - Phase XV)

16MnCr5 Heat Treat

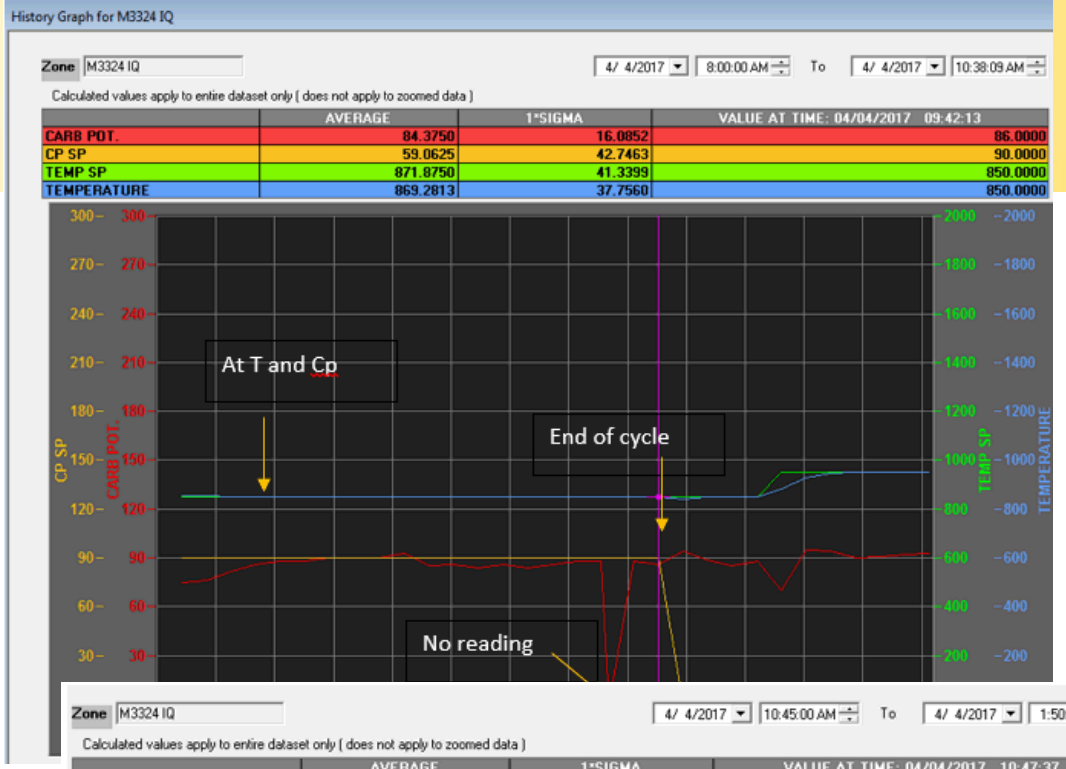
BUILT FOR IT.

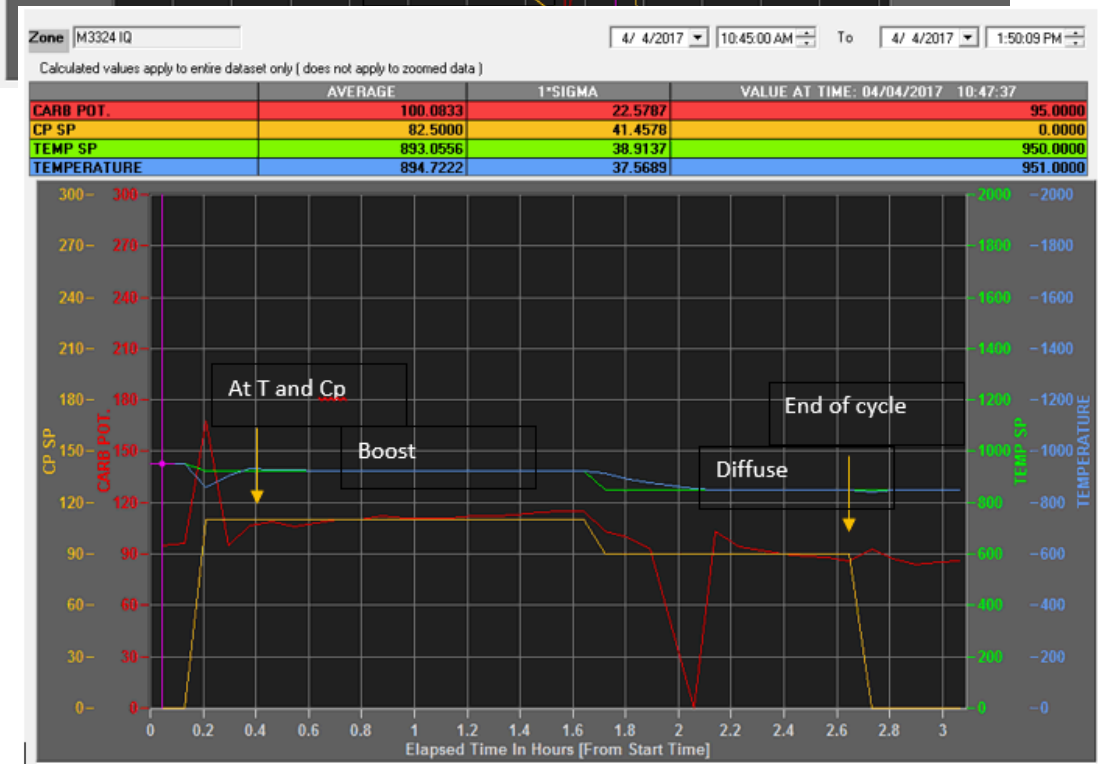
Sample Fixturing

- All samples were hung for heat treat
- Each heat treat batch included all samples for a given heat treat condition.
- Three heat treat conditions were run for axial and bend samples
  - Shallow Case: Target 0.25 mm hardened depth (Depth to 50 HRC)
  - Deep Case: Target 0.50 mm hardened depth
  - Simulated Core: Run shallow case recipe with neutral carbon potential.

Heat Treat Recipes

- Heat treat in an integral quench batch furnace
  - Oil Quench
  - Oil Temperature Maintained at: 49C
- Shallow Case (simulated core with neutral atmosphere)
  - Temp: 850 C
  - Carbon Potential: 90
  - Time: 80 min
- Deep Case
  - Step 1:
    - Temp: 925C
    - Carbon Potential:110
    - Time: 80 min
  - Step 2
    - Temp: 850C
    - Carbon Potential: 90
    - Time: 40 min
- Temper: 164C, 120 min



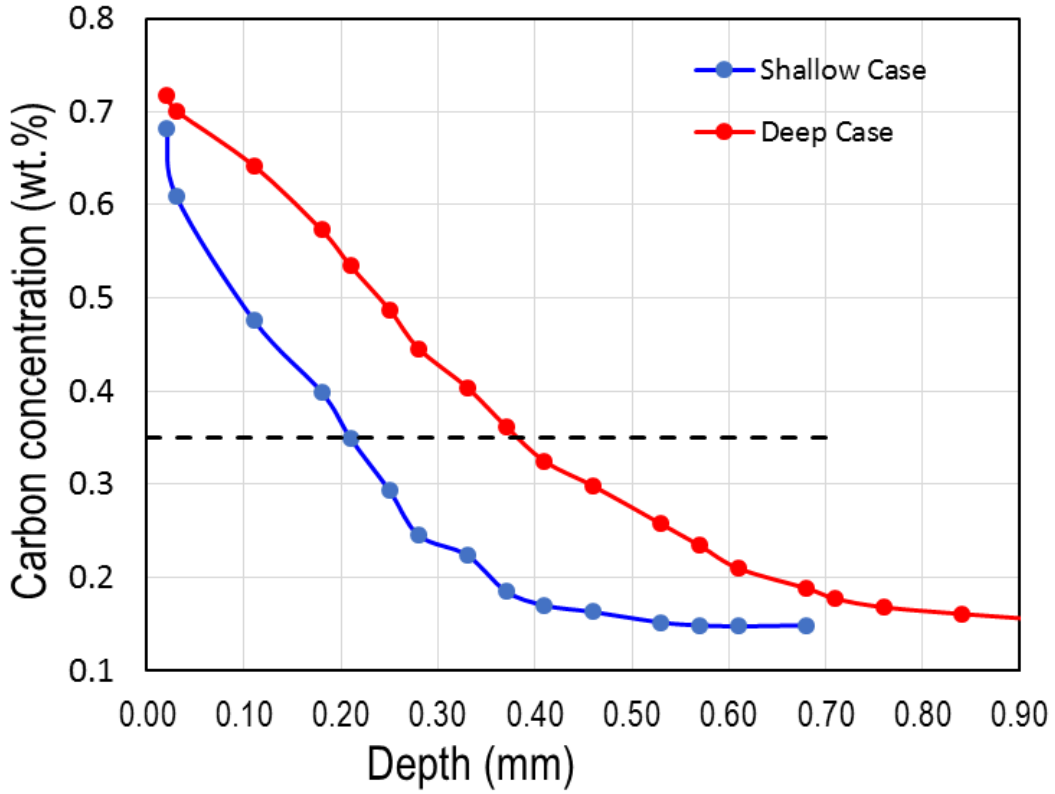


INNOVATION & TECHNOLOGY DEVELOPMENT DIVISION

Carbon Profiles

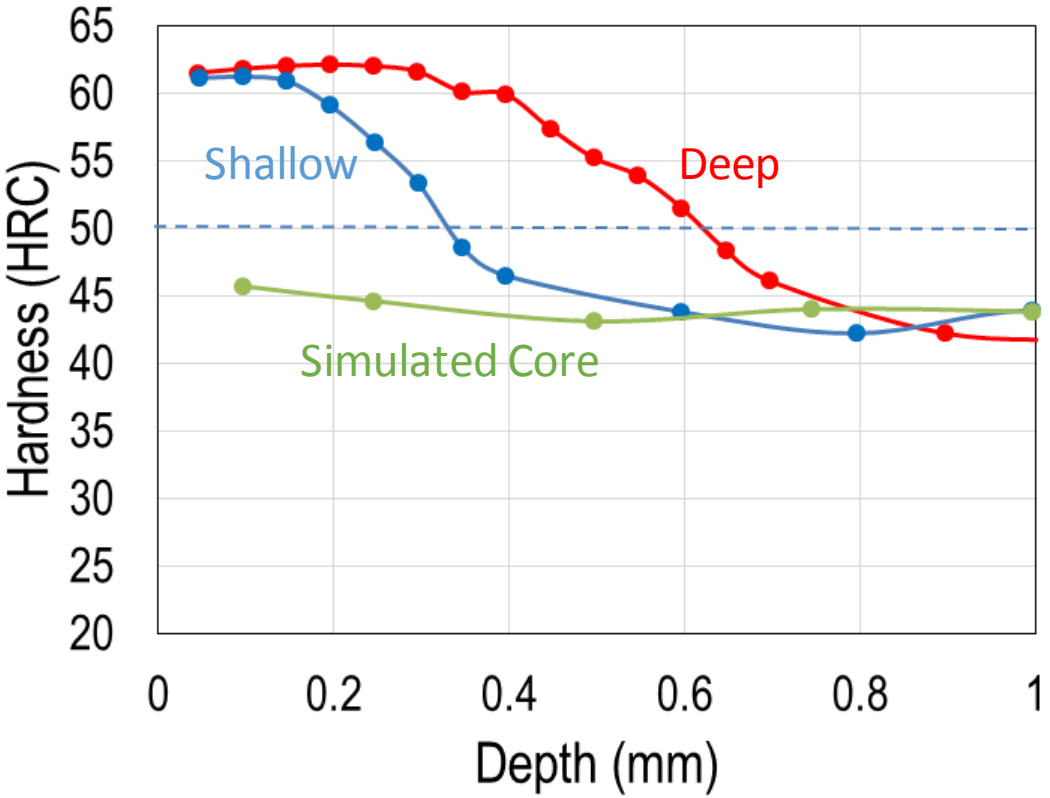
- Measurements made on 25 mm disc found in box with samples
  - Disc bisected to make two discs and then ground flat.
  - Disc hung in deep case and shallow case heat treat runs.
  - Carbon measured using OES Spectrometer (1 year old).
  - Surface of sample progressively ground to obtain depth profile.
  - Full chemistry of disc measured to verify 16MnCr5

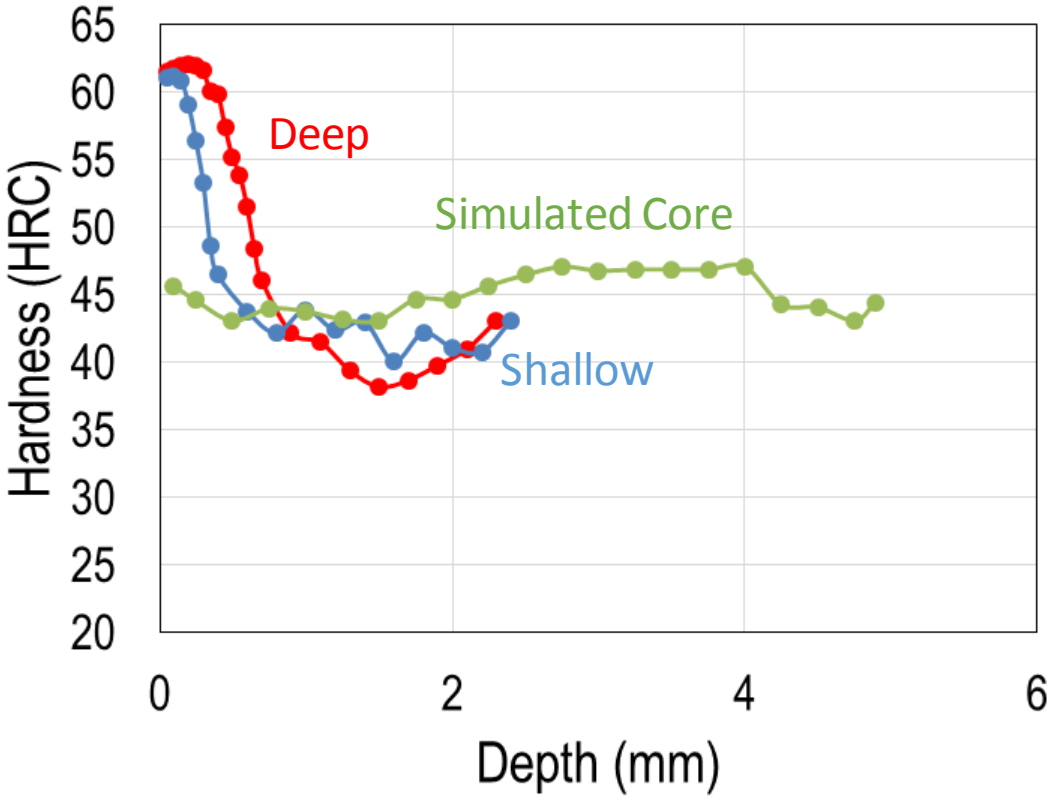
Element (wt%)	Measured	DIN EN 10084 16MnCr5, 1.7131
Carbon	0.16	0.14-0.19
Manganese	1.17	1.00-1.30
Phosphorus	0.02	0.025 max
Sulfur	0.034	0.035 max
Silicon	0.07	0.40 max
Nickel	0.11	- -
Chromium	1.03	0.80-1.10
Molybdenum	0.03	- -
Copper	0.24	- -
Aluminum	0.018	- -



Results – Axial Fatigue Bars

Hardness converted from Vickers Hardness (500g)





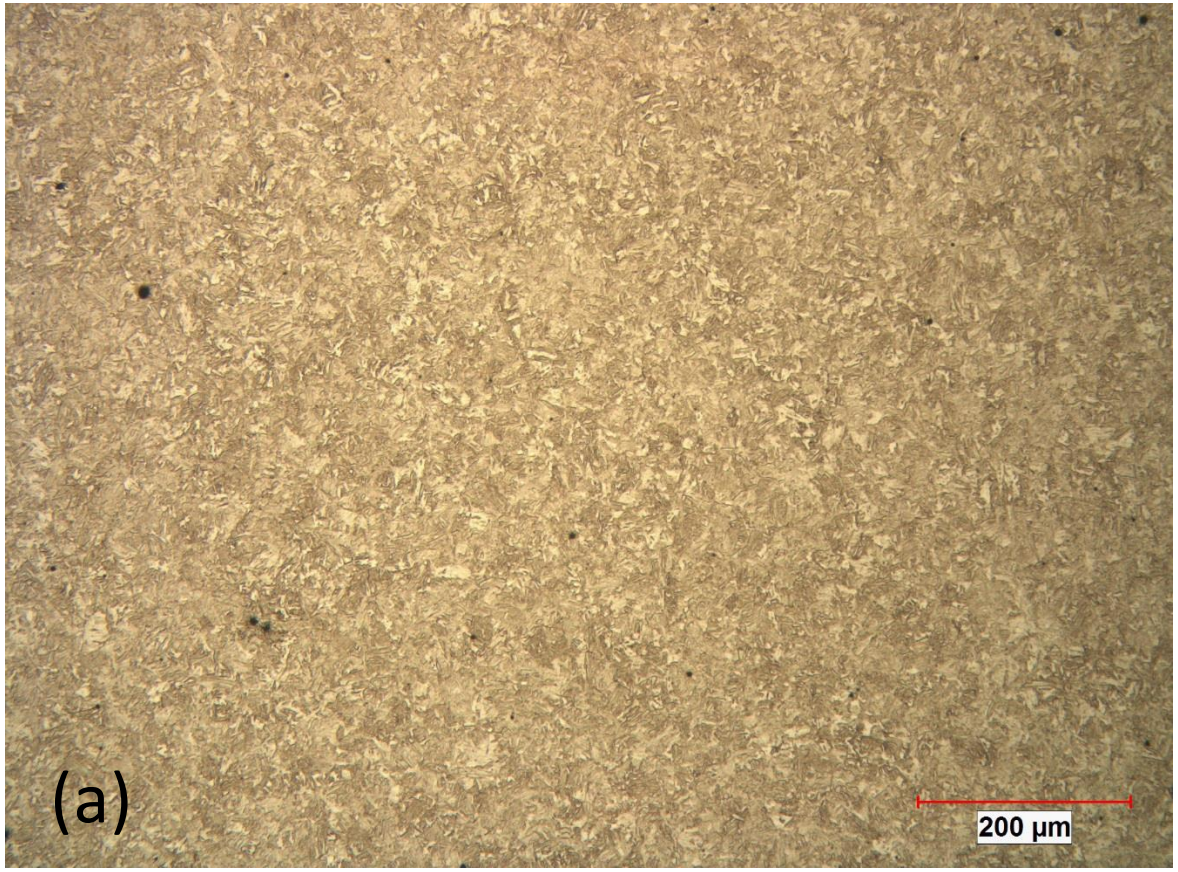
Target Hardened Depth:

- Shallow Case: 5% of gage width (0.32 mm) or 0.25 mm
- Deep Case: 10% of gage width (0.636 mm) or 0.5 mm

Actual Hardened Depth:

- Shallow Case: 0.32 mm
- Deep Case: 0.62 mm

Axial Fatigue – Simulated Core - Core



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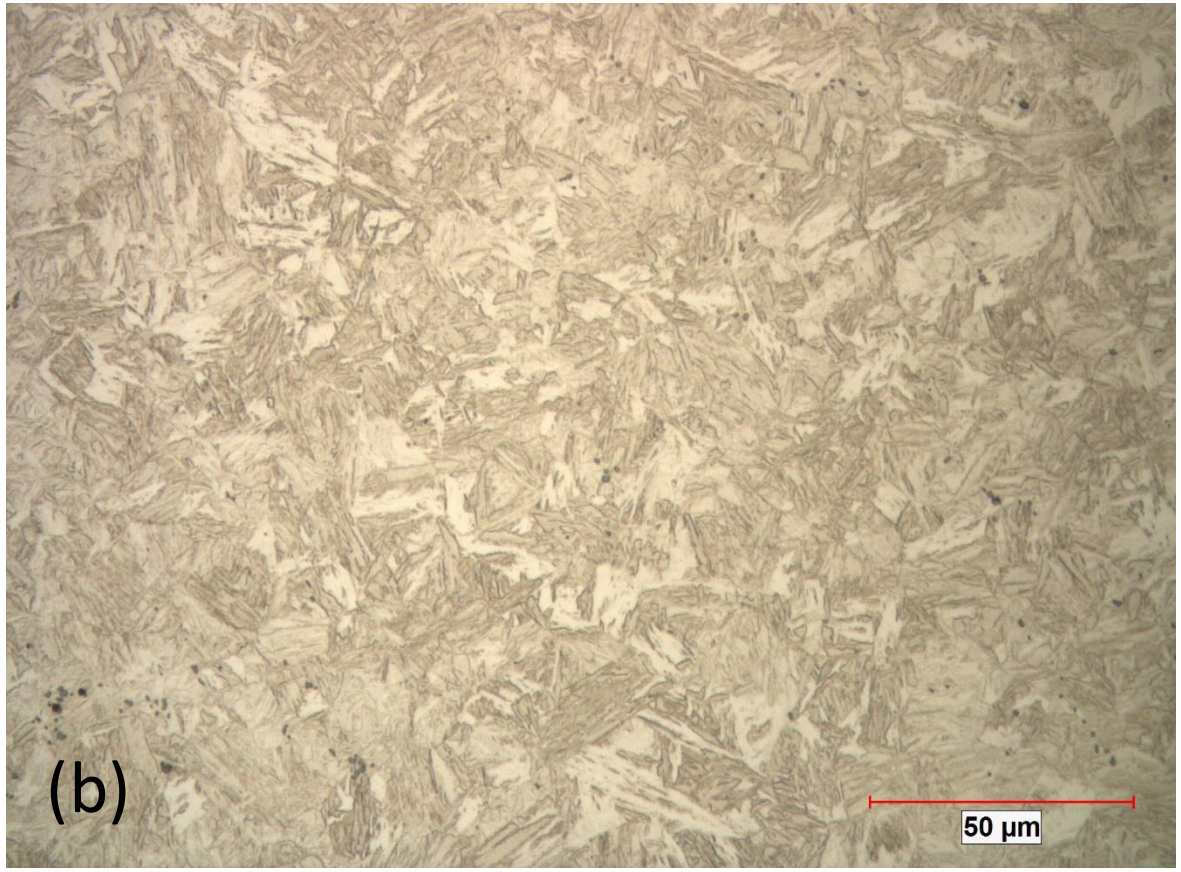

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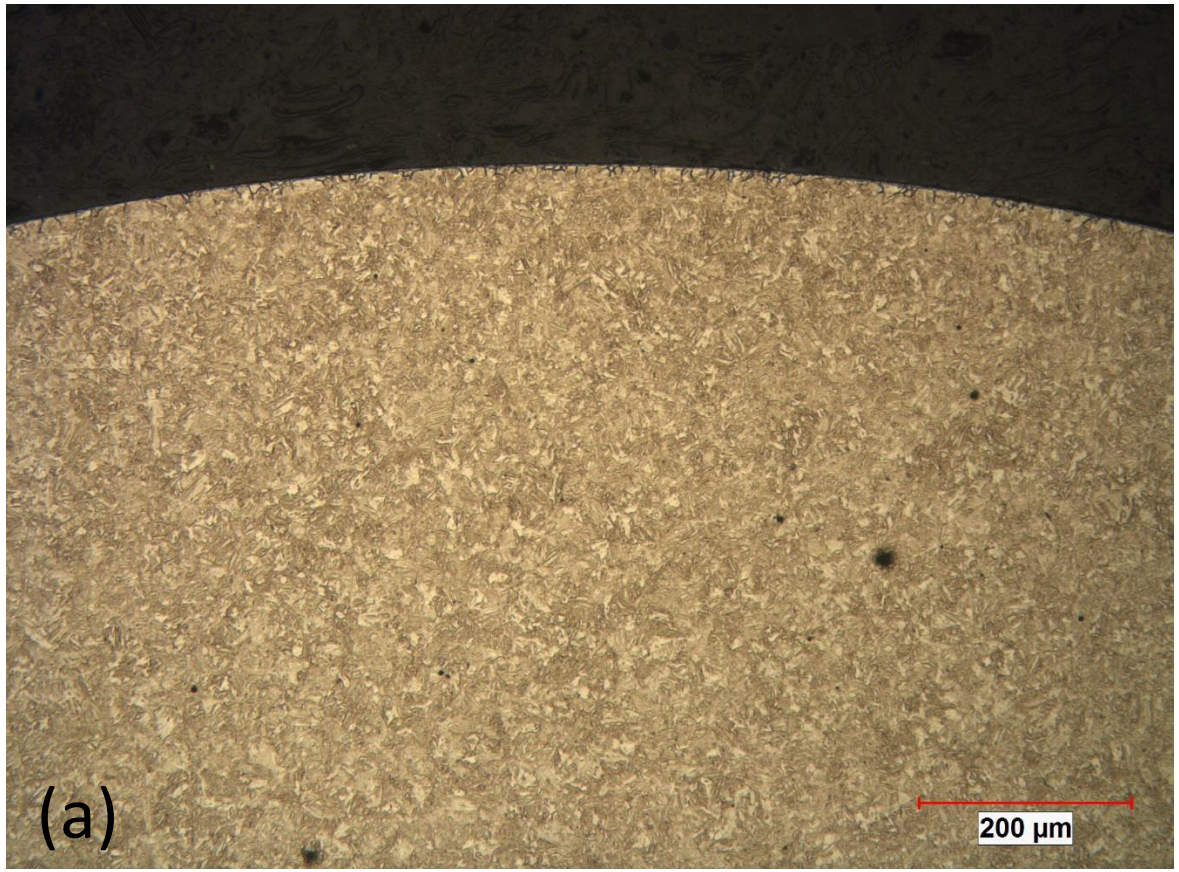
Axial Fatigue – Simulated Core - Surface



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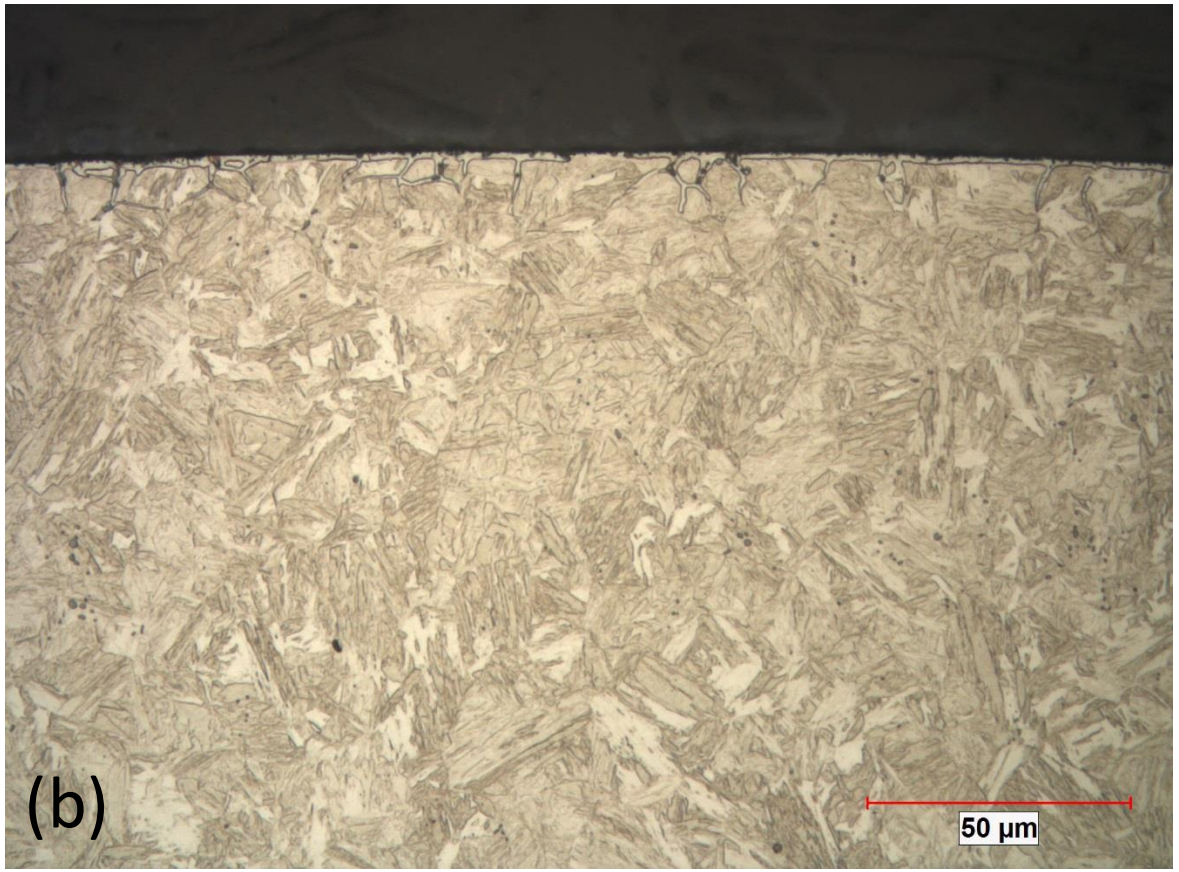

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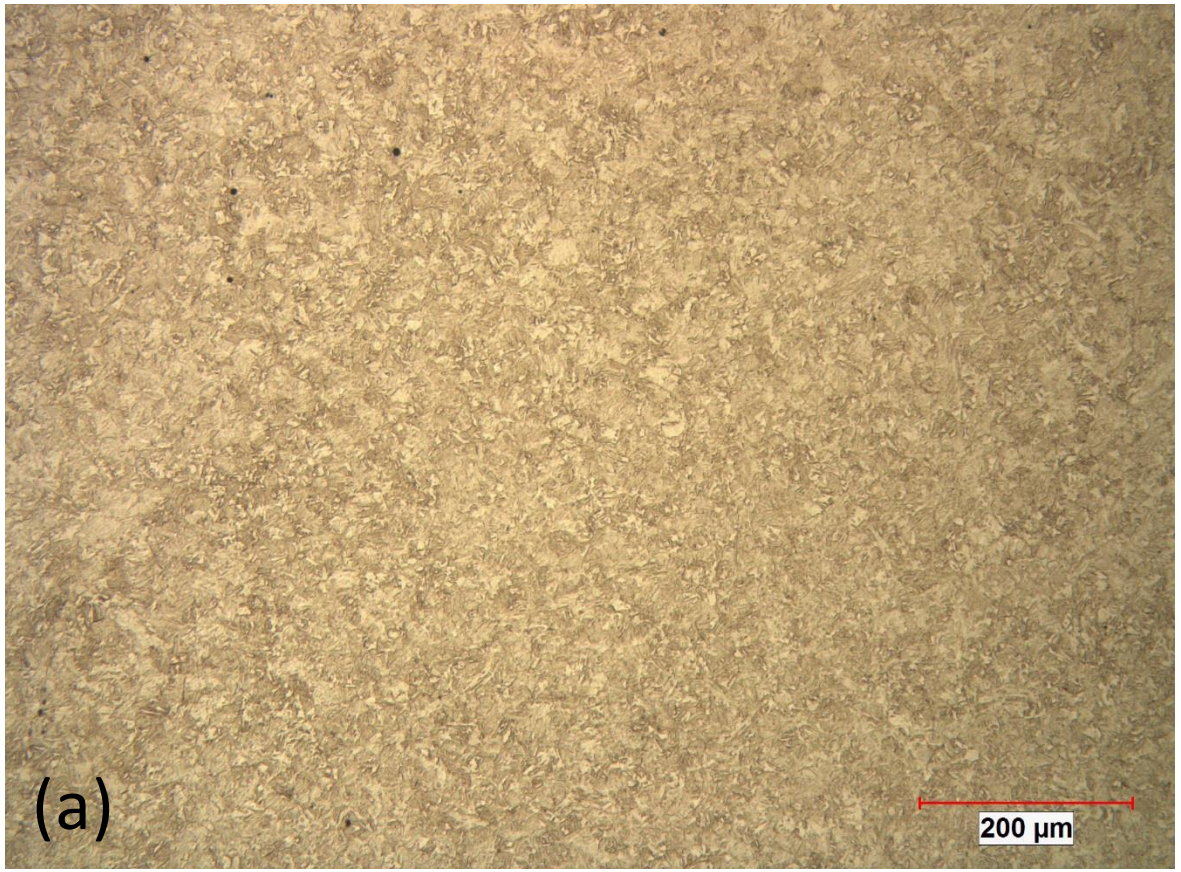
Axial Fatigue – Shallow Case - Core



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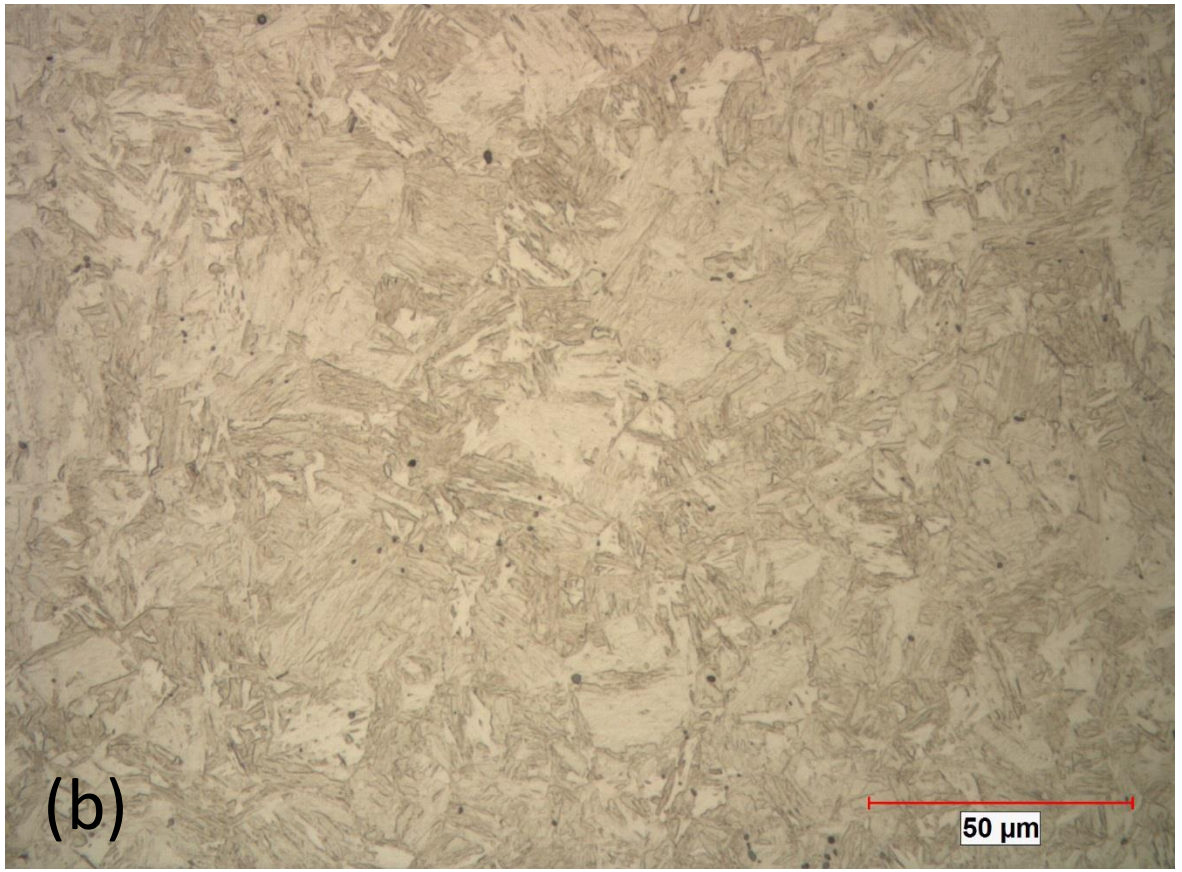

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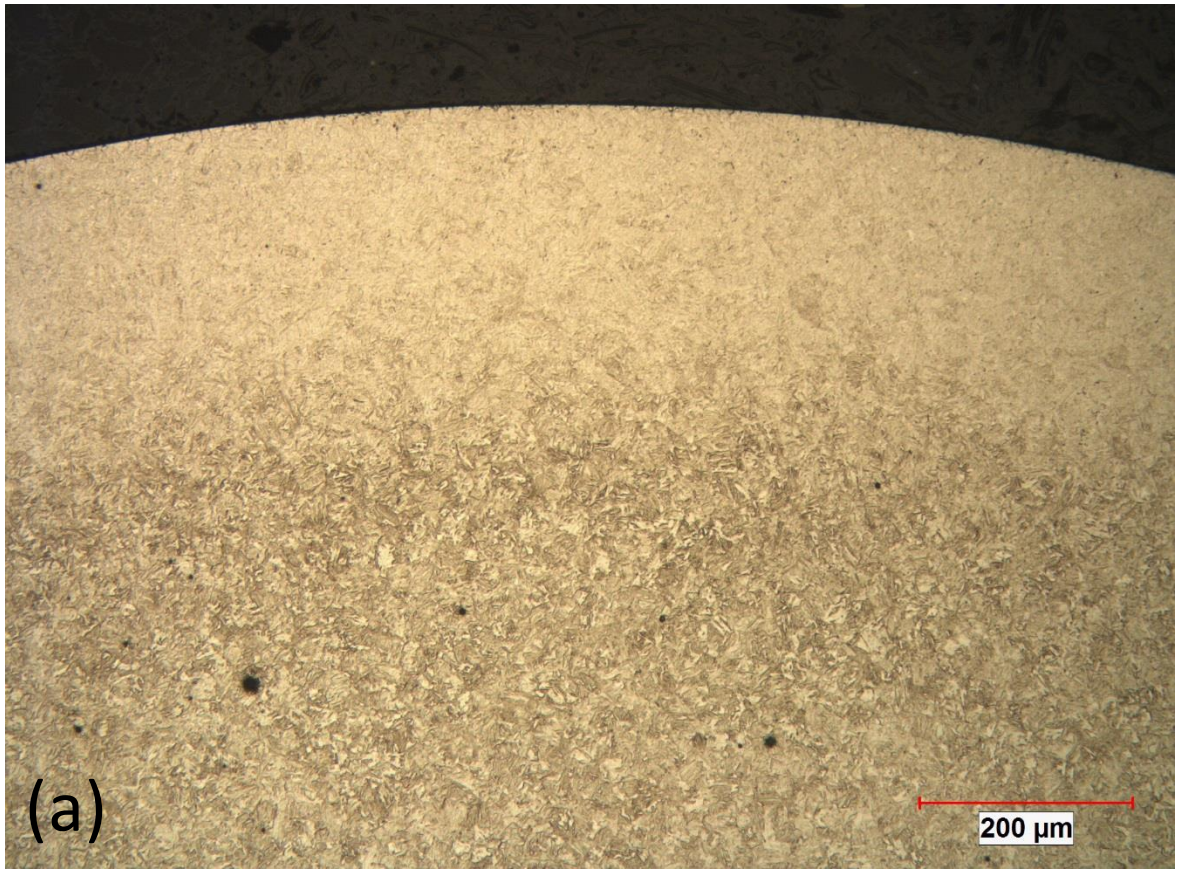
Axial Fatigue – Shallow Case – Surface



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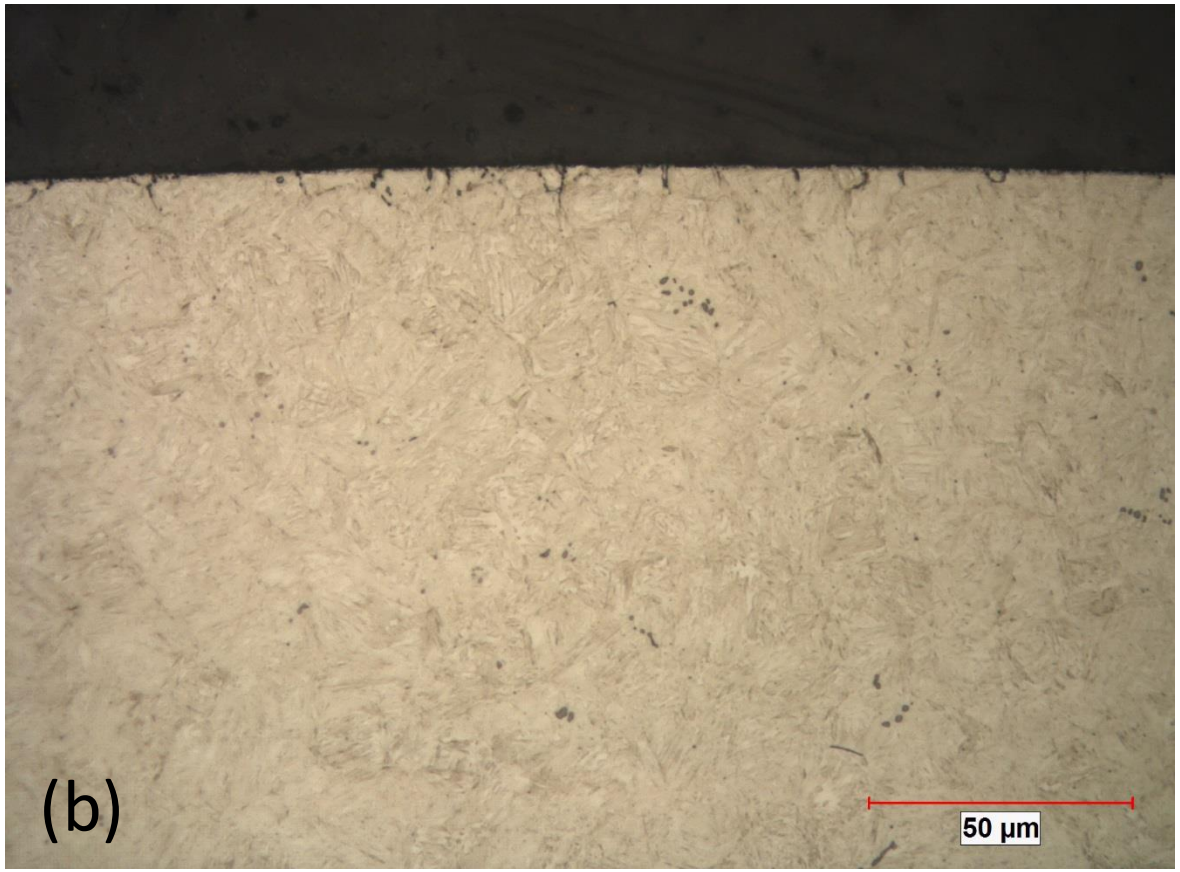

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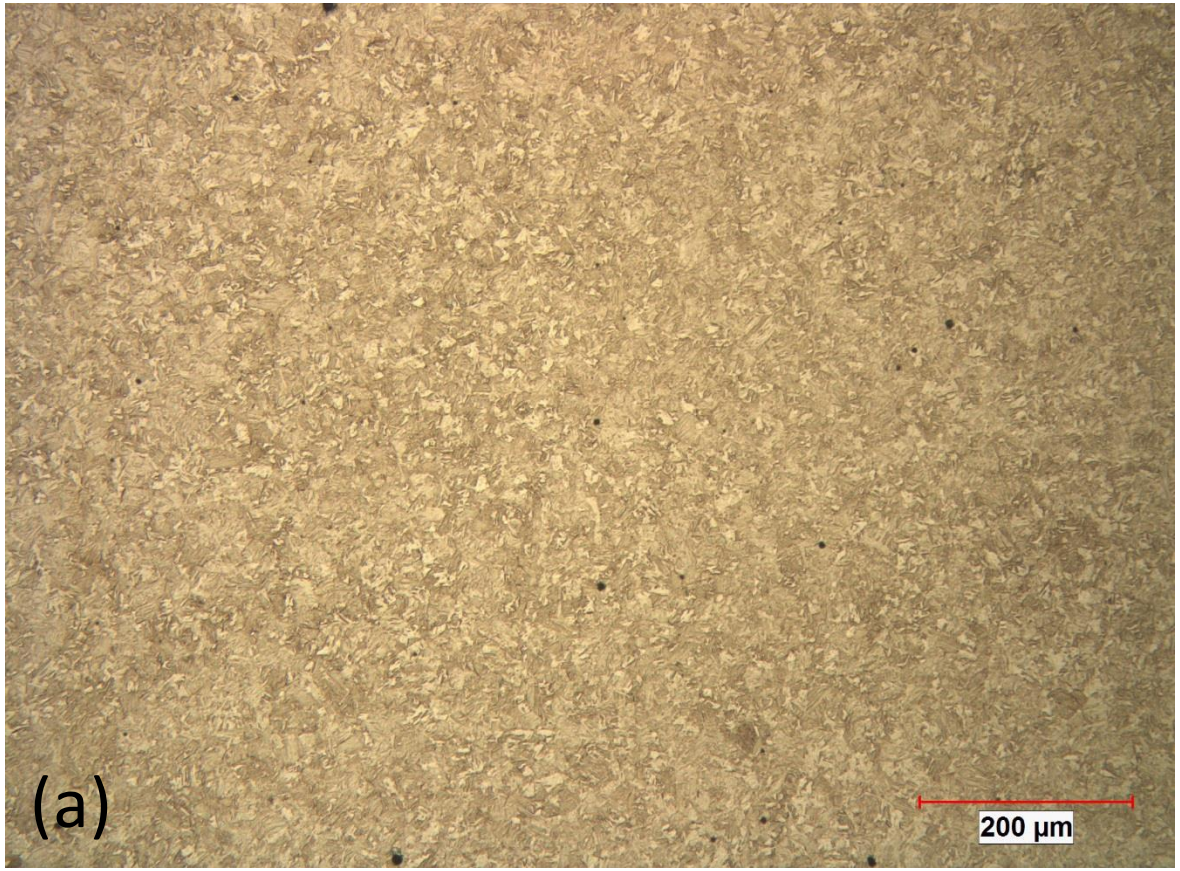
Axial Fatigue – Deep Case – Core



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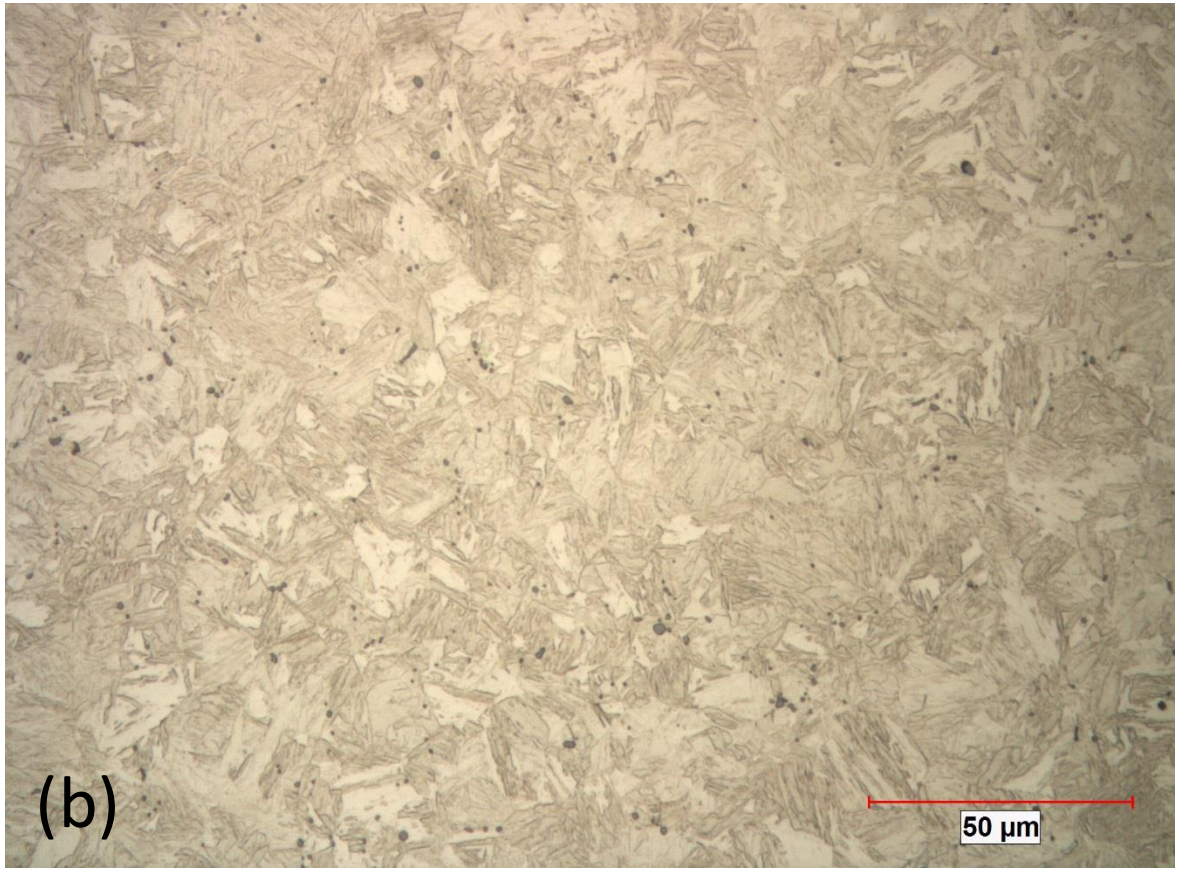

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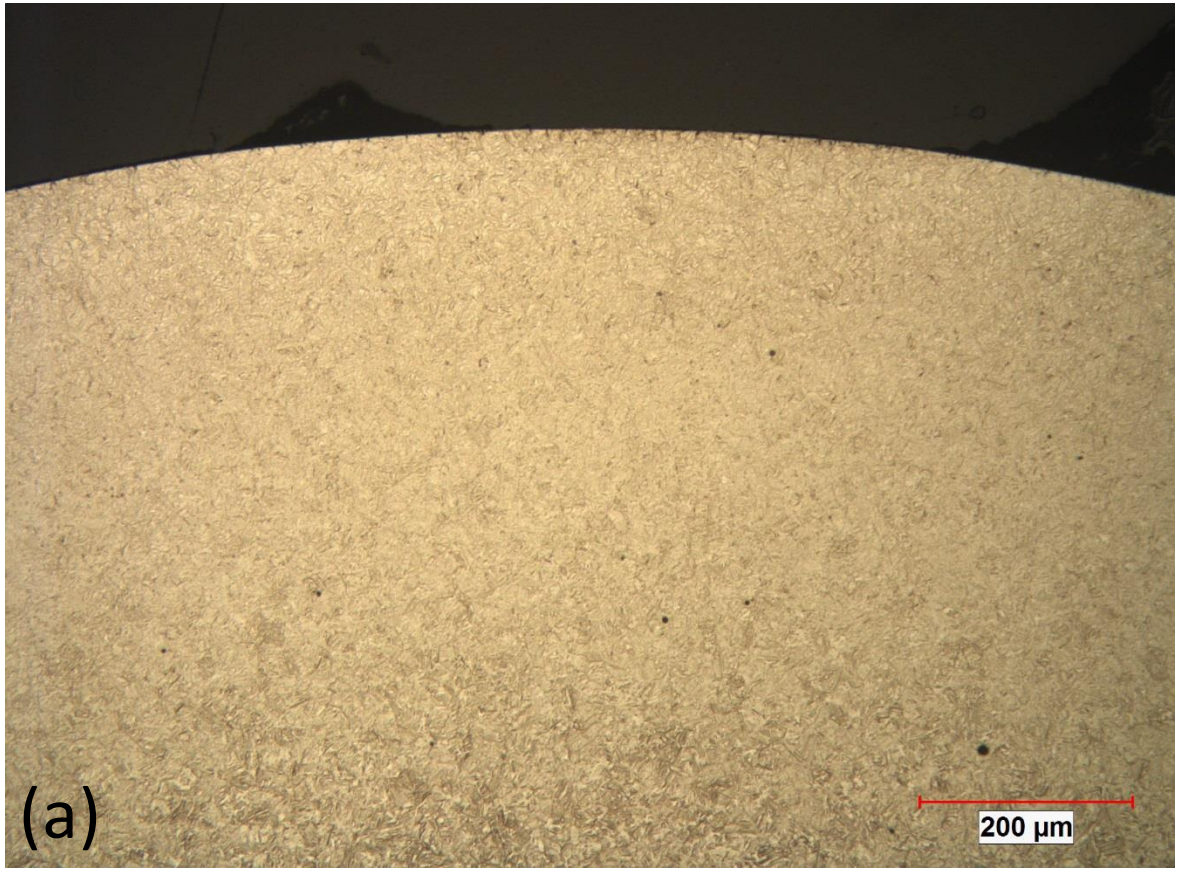
Axial Fatigue – Deep Case – Surface



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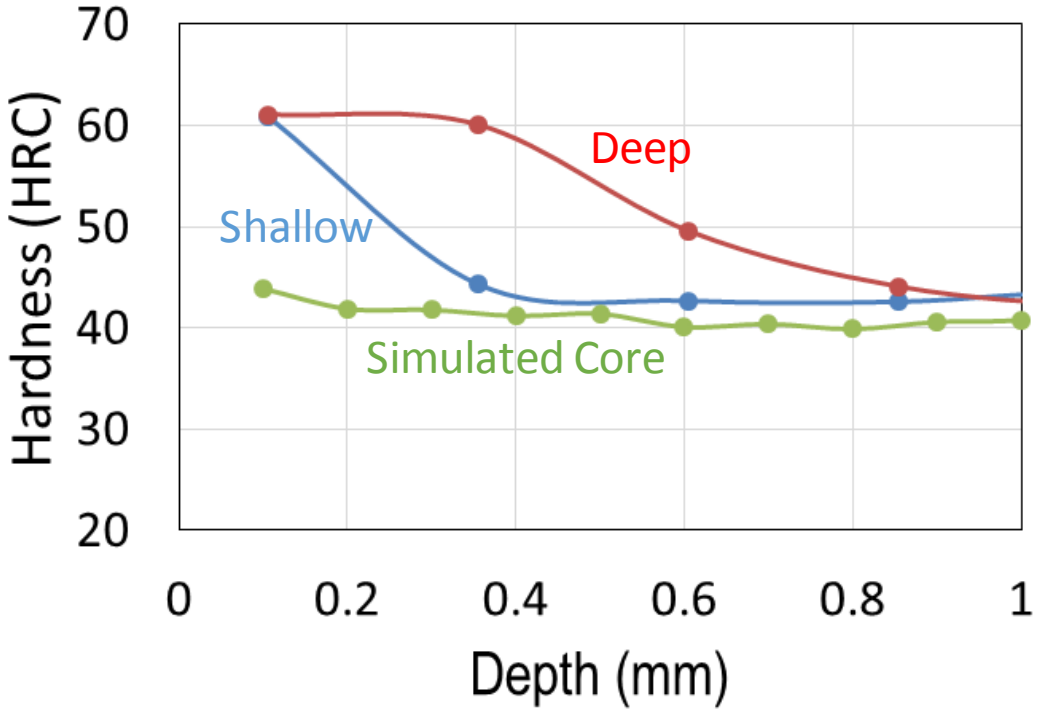
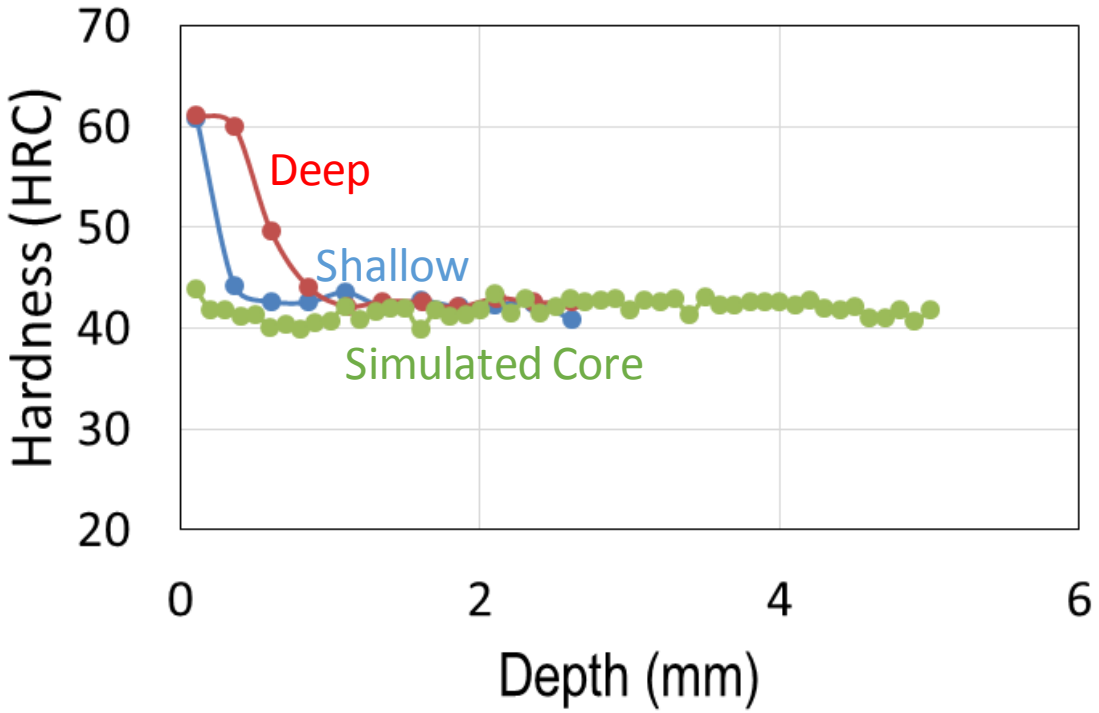
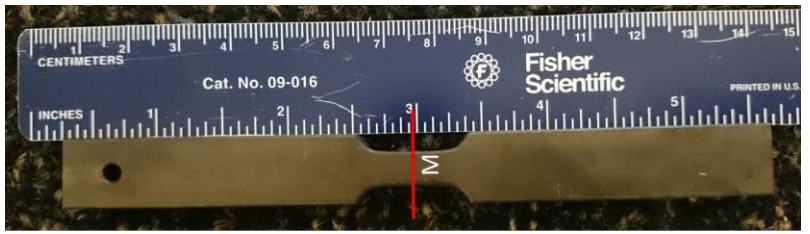
Results – Bend Bars



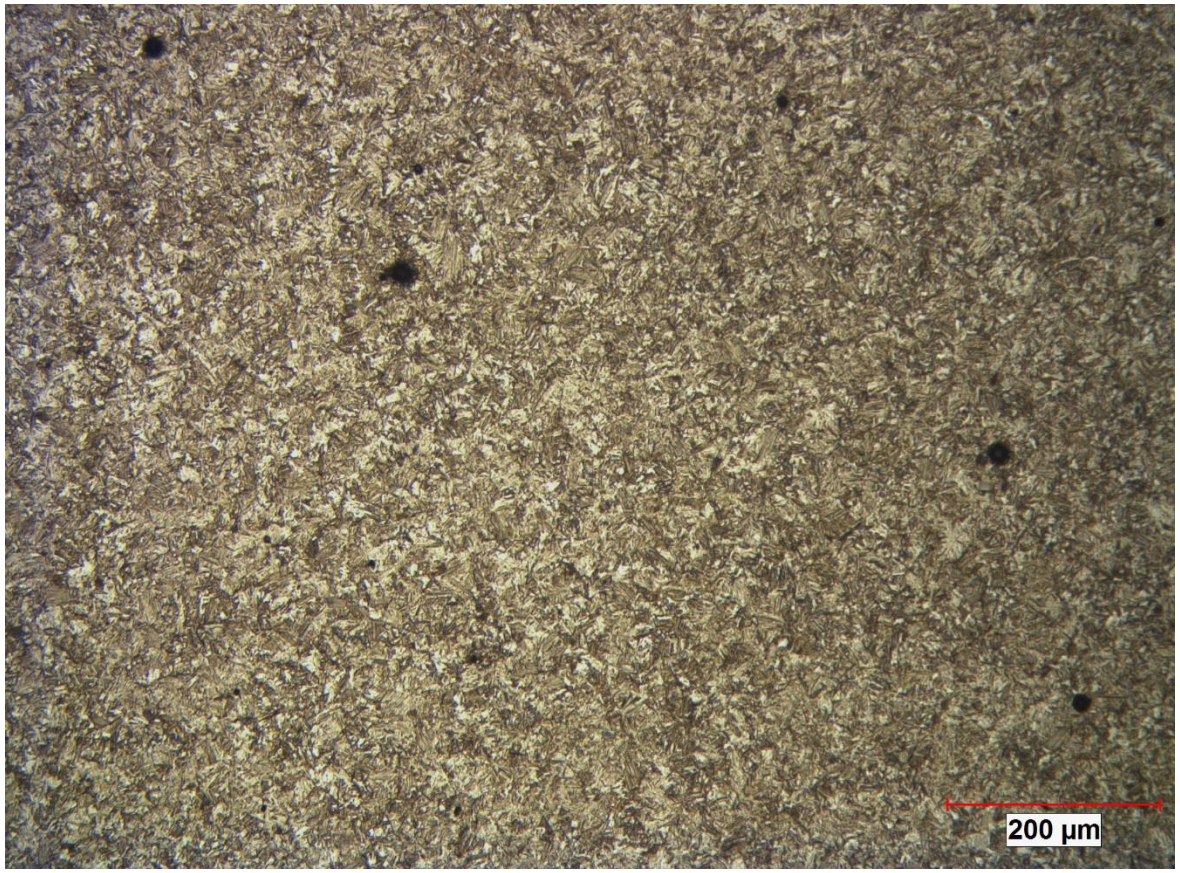


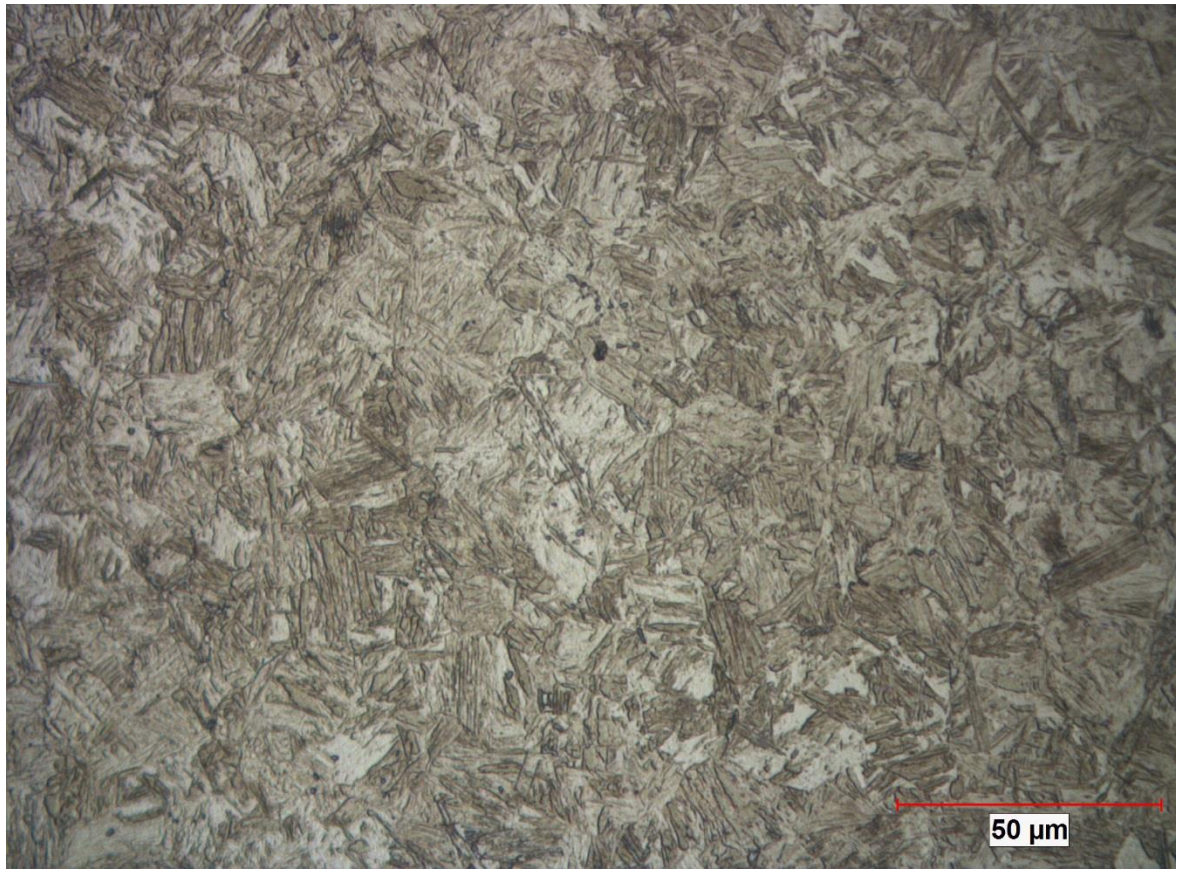
Actual Hardened Depth:

- Shallow Case: 0.25 mm
- Deep Case: 0.6 mm

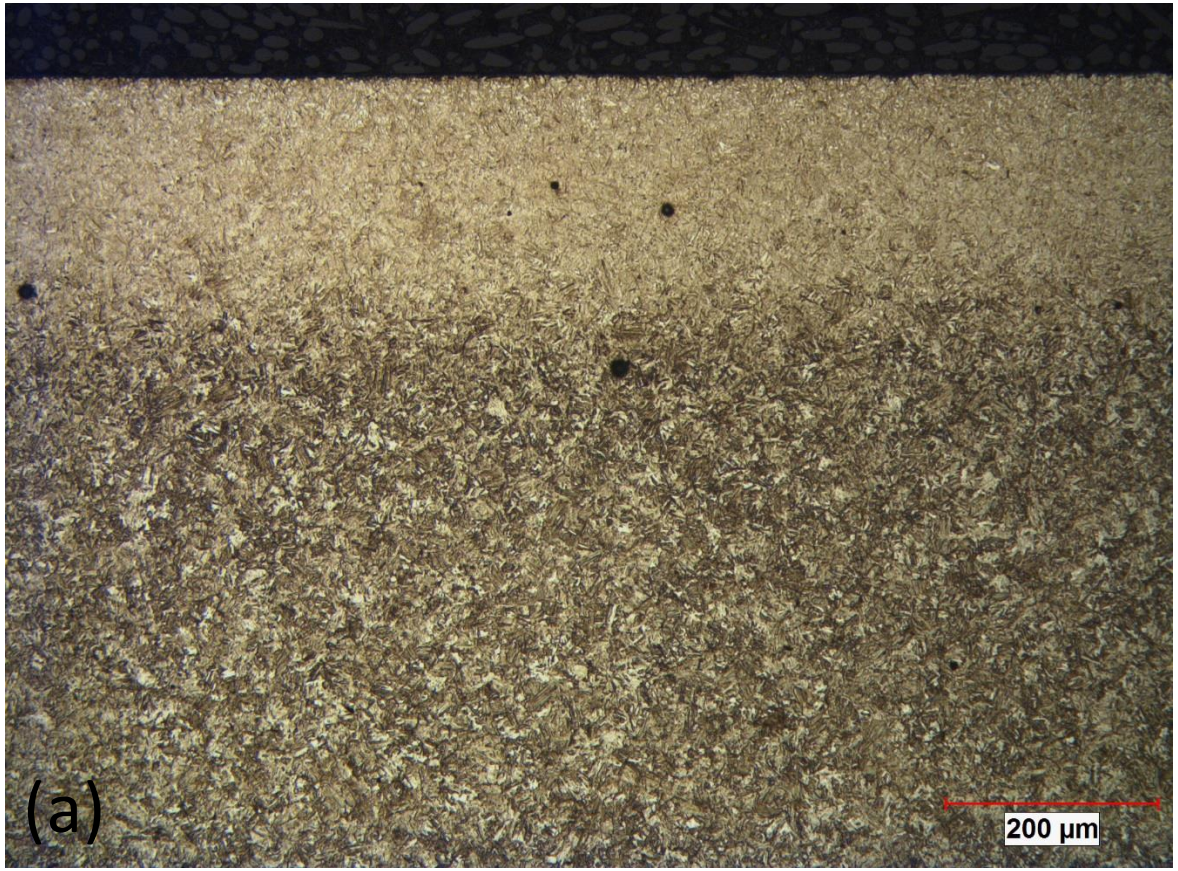


Bending Fatigue – Shallow Case – Core





Bending Fatigue – Shallow Case – Surface



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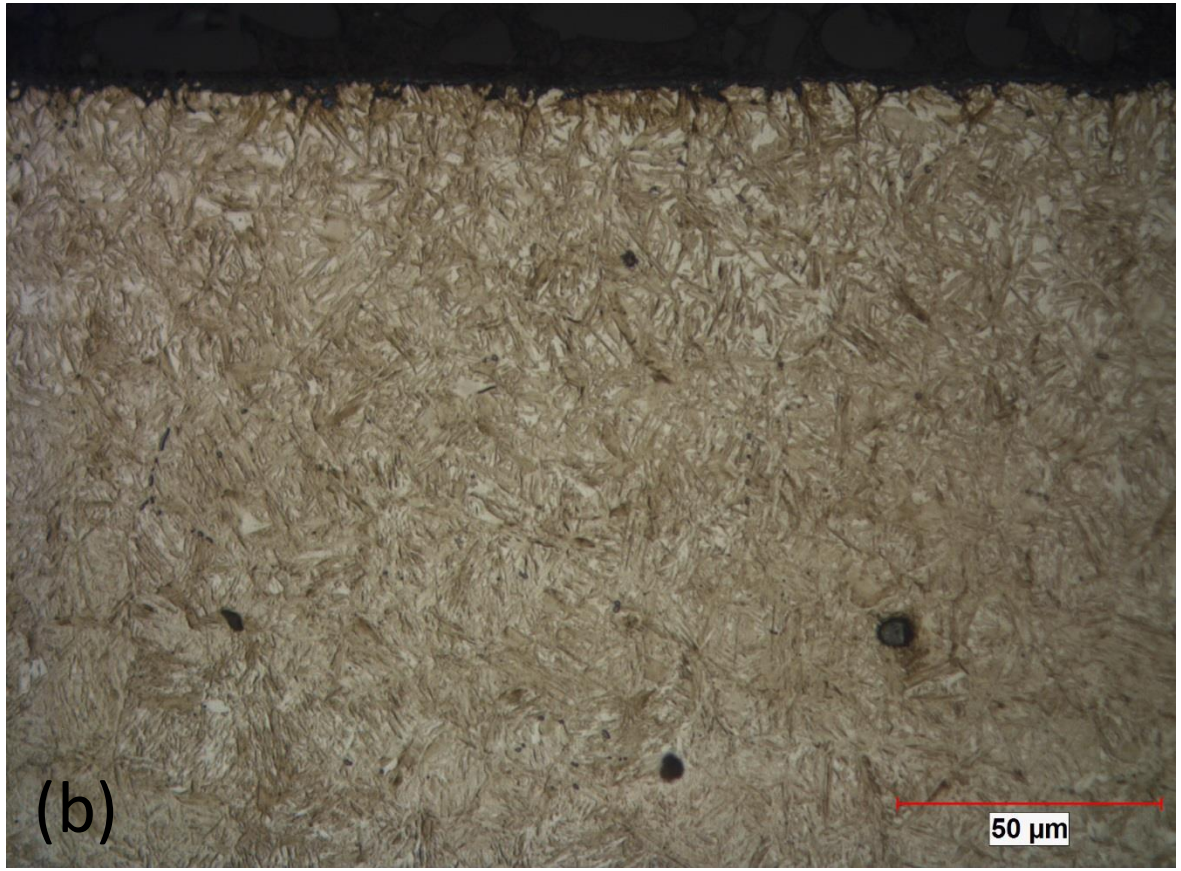

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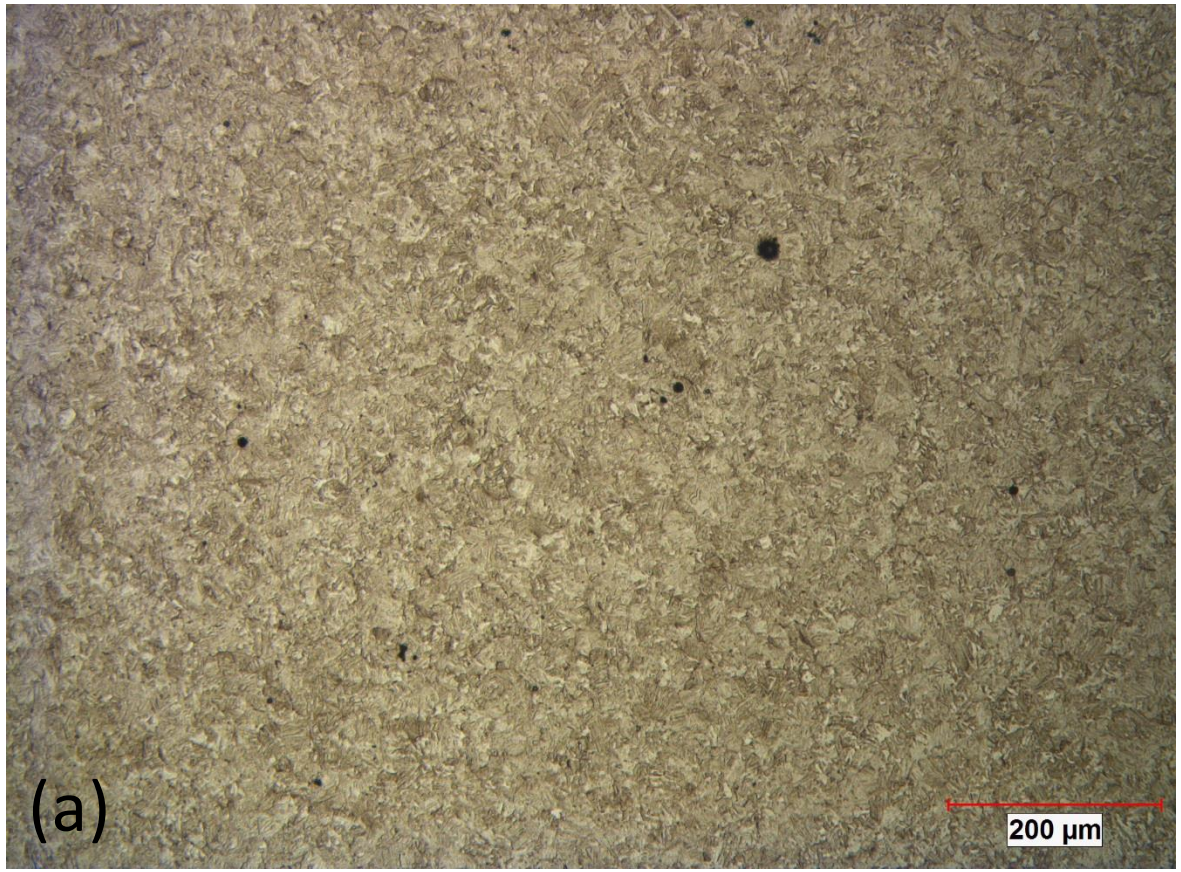
Bending Fatigue – Deep Case – Core



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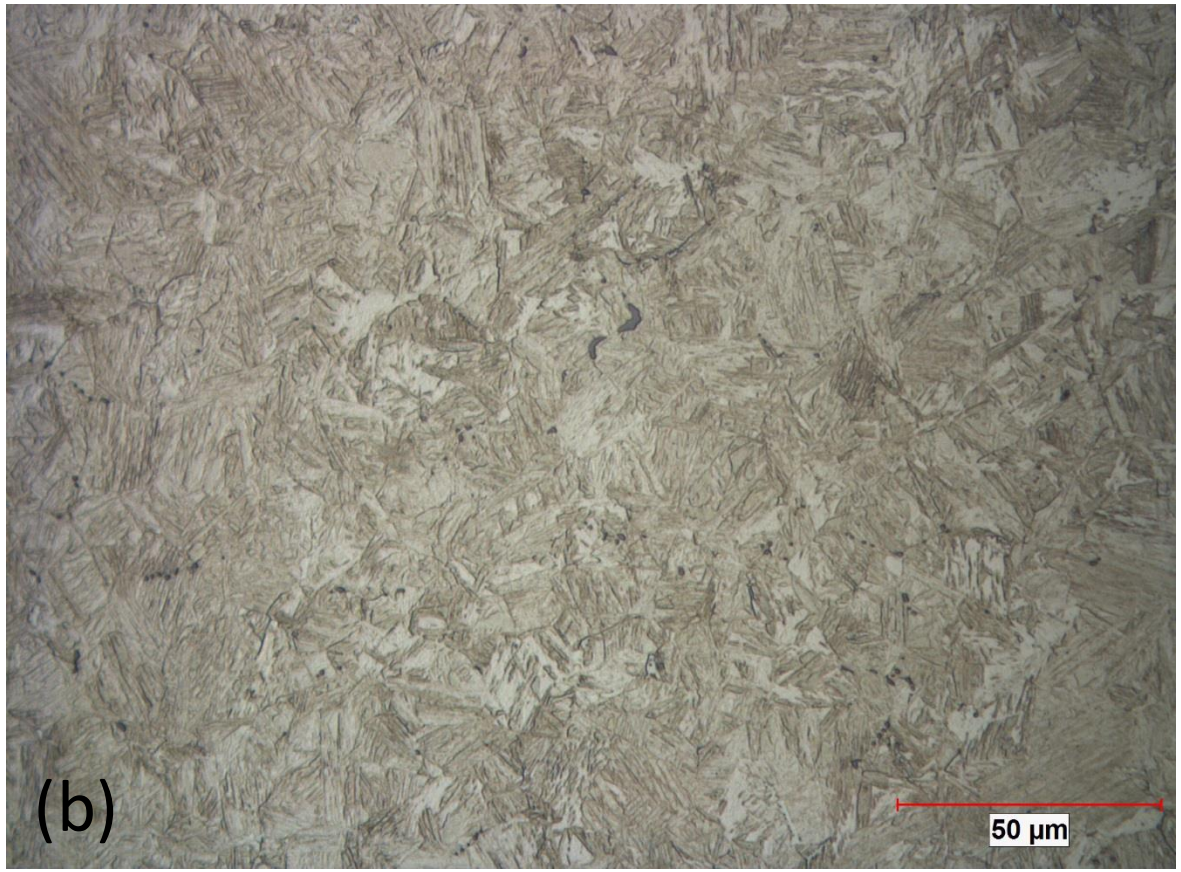

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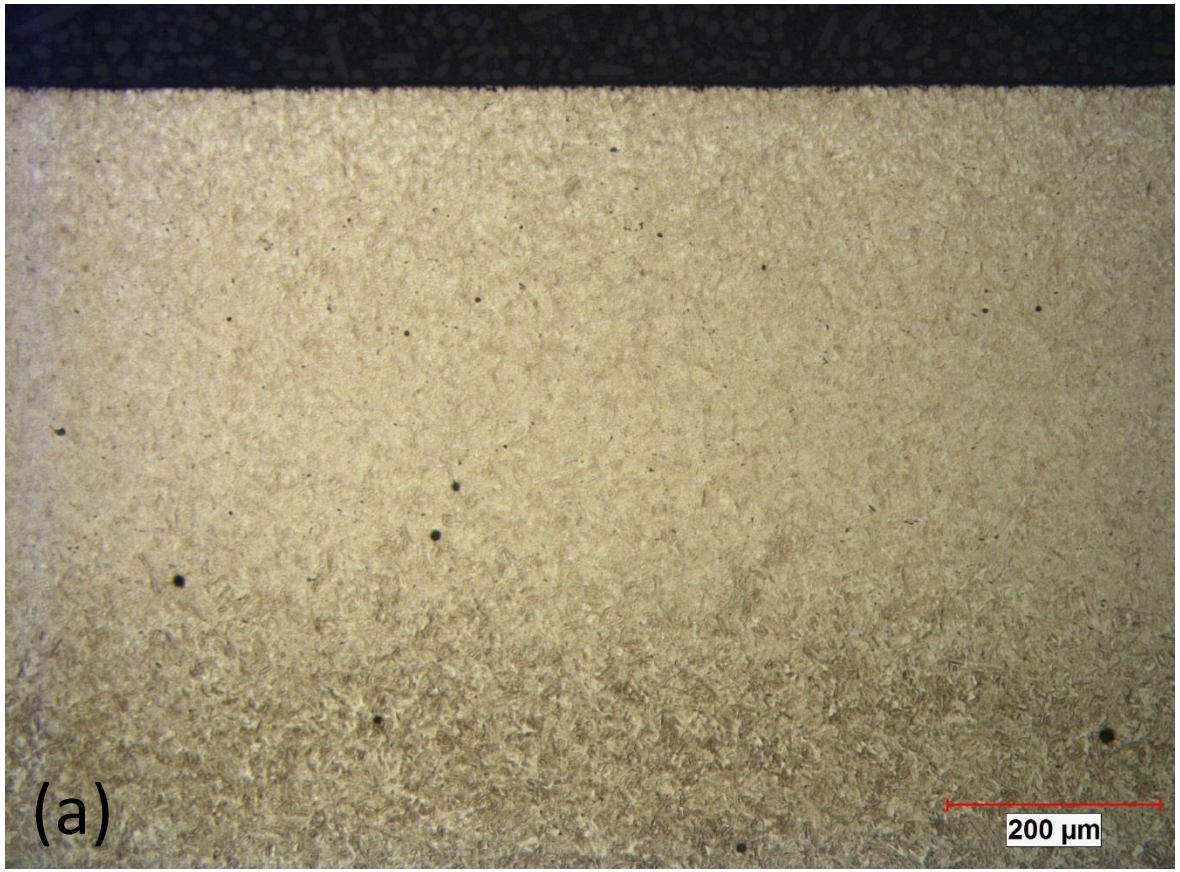
Bending Fatigue – Deep Case – Surface



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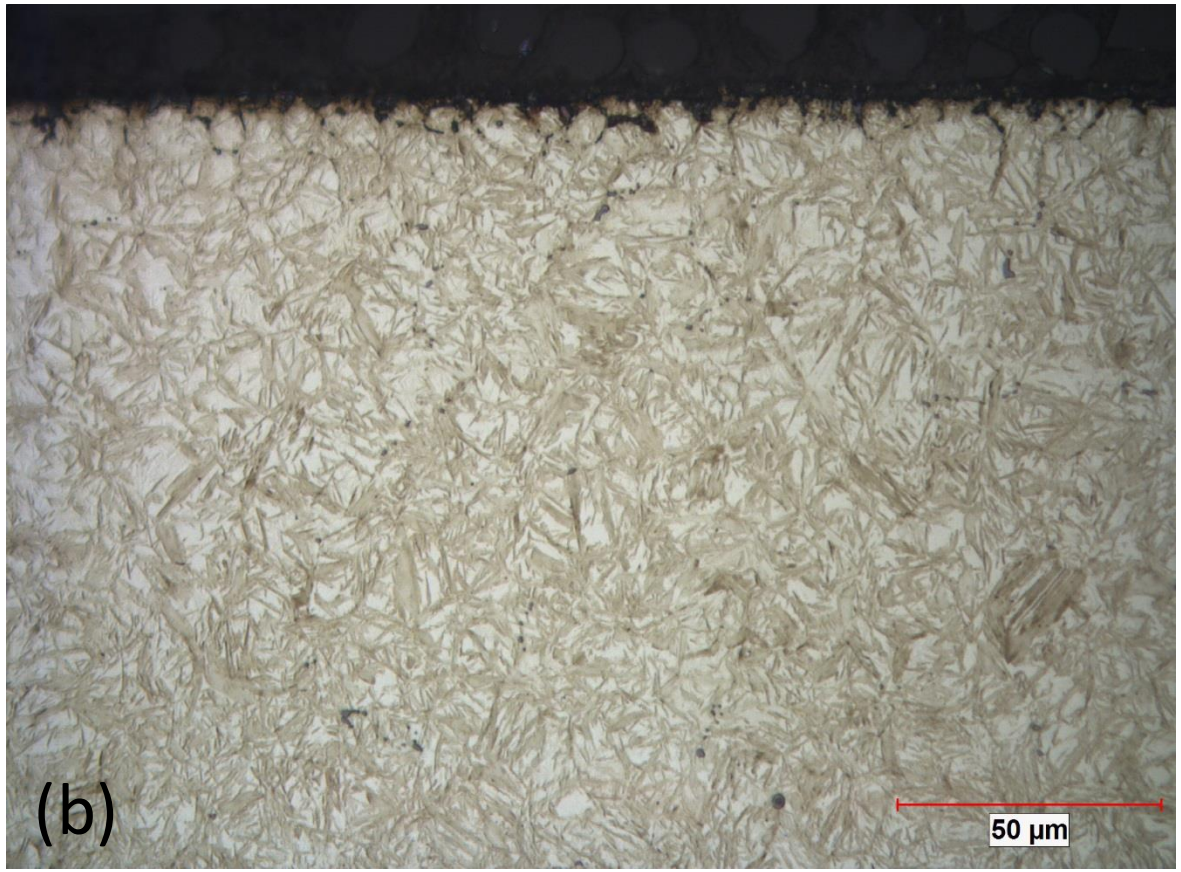

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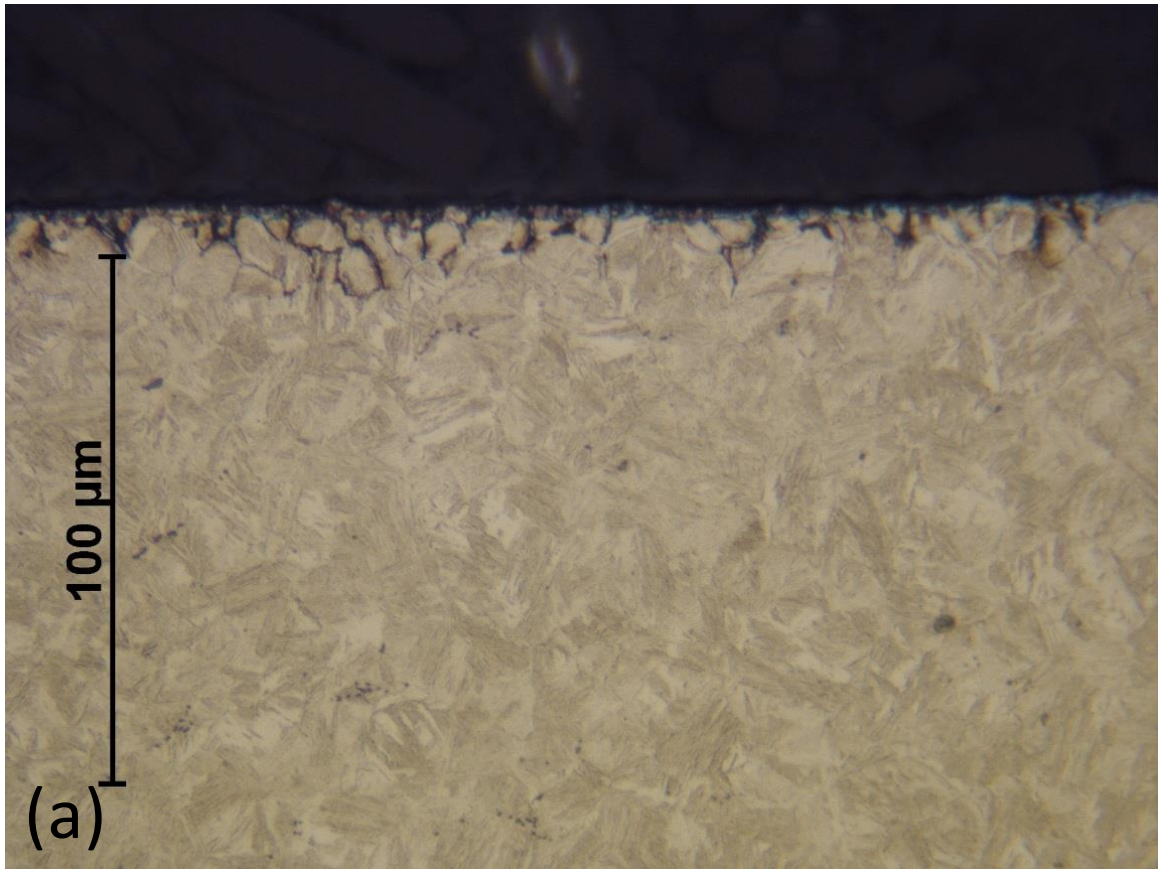
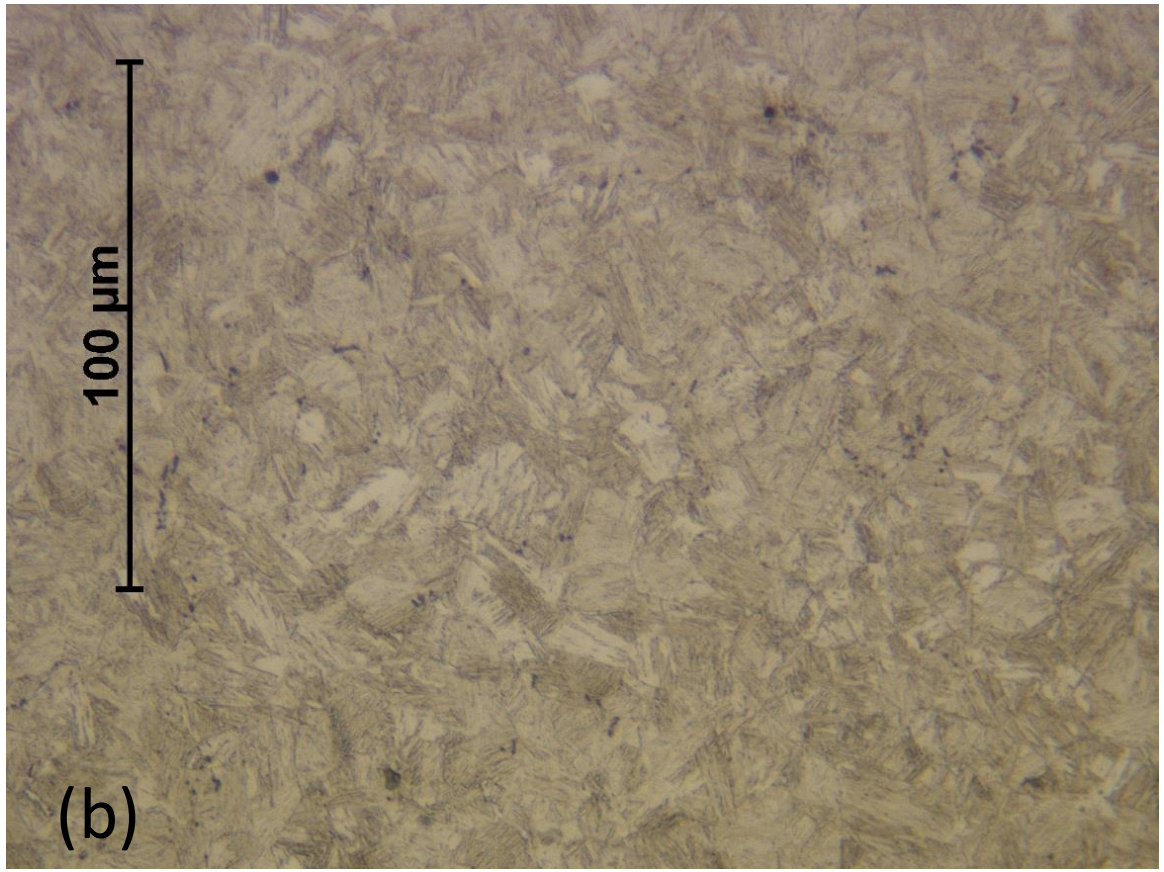
Bending Fatigue – Simulated Core



Surface



Core