

Summary slides



Questions

How does residual stress from LPBF 316L specimens impact SCC? What heat treatments impact this SCC behavior?

Approach

Control residual stress of powder bed fusion specimen with cutting/heat treatments.
Assess SCC behavior through boiling $MgCl_2$ exposures (ASTM G36-94)

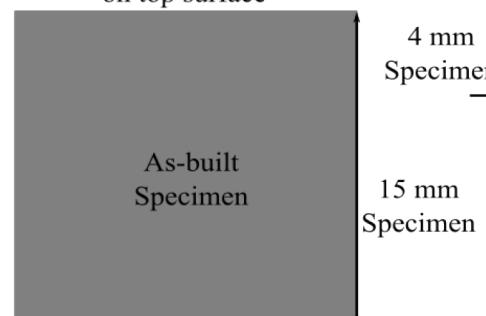
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- Two batches of 25, 1.5 cm, cubes fabricated with different porosity levels.
- **5 different cut heights to produce specimens with significantly different residual stresses.**
- Density measurements: “Good batch, 99.0% dense”, “Porous batch, 95.4% dense”

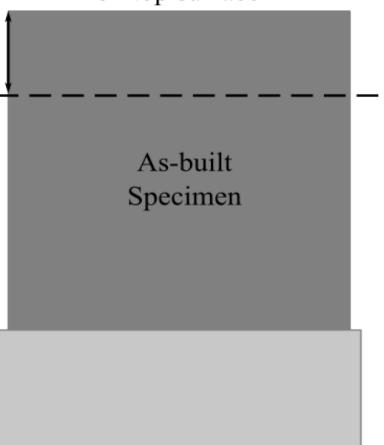
Dense



Large residual stress after cut on top surface



Small residual stress after cut on top surface



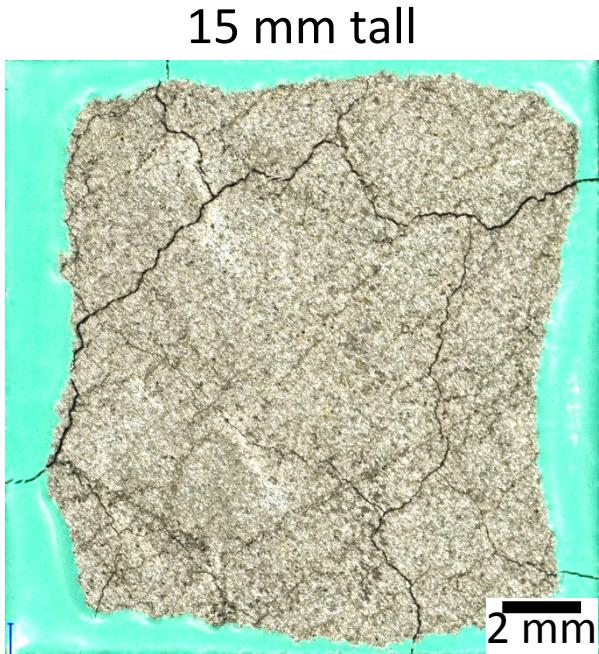
How do residual stress and microstructure affect SCC susceptibility in LPBF 316L SS?

2

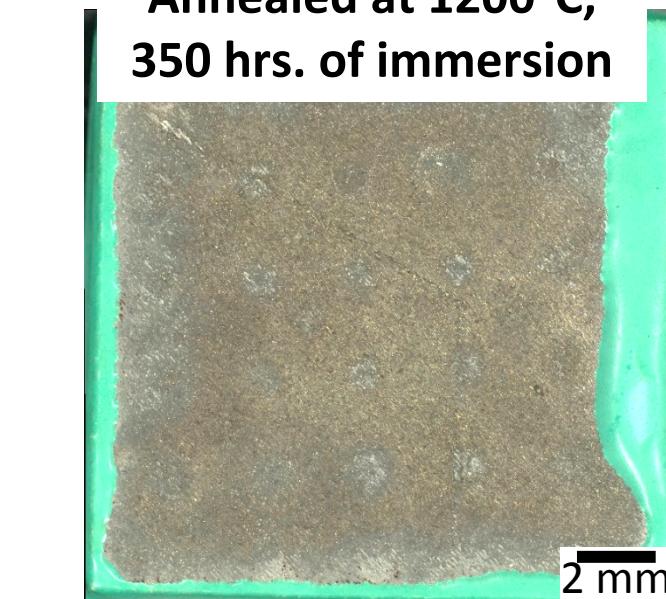
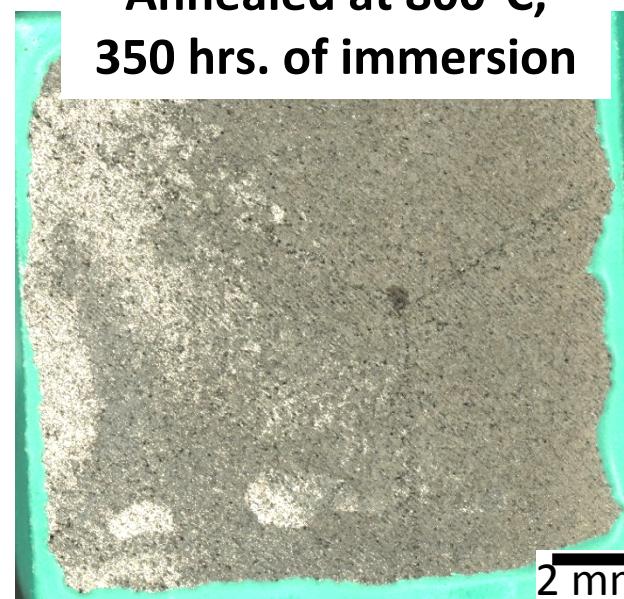


Average Res. Stress, σ_{xx} (MPa)

15 mm	390
15 mm 800 C, 1 hr	88
10 mm	306
4 mm	60
4 mm 600 C, 1 hr	46



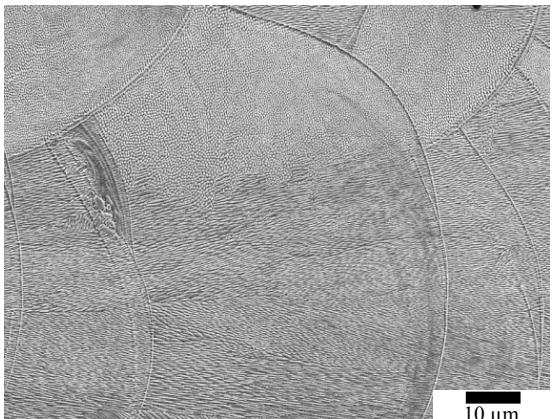
- Cracks observed in both 15 mm and 4 mm samples annealed at 600 C
- No cracks observed in 15 mm and 4 mm samples annealed at 800 C or 1200 C even though residual stress in 15 mm samples annealed at 800 C was greater than the as-built 4 mm sample!
- **Microstructural evolution during annealing at 800 C significantly decreases SCC susceptibility**



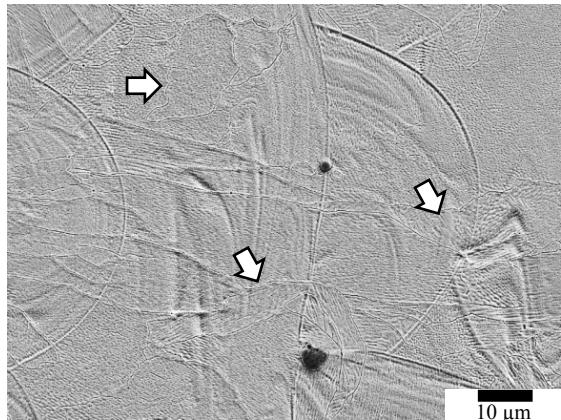
How does annealing affect the microstructure?

3

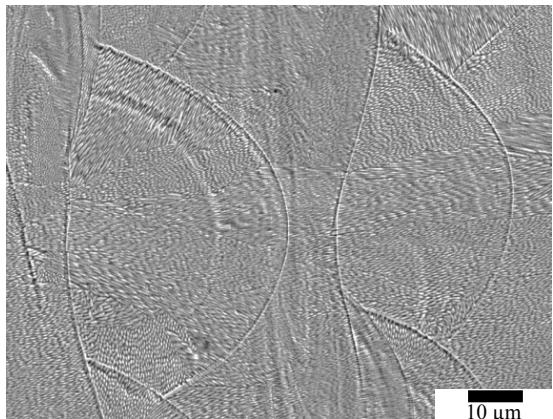
As-printed



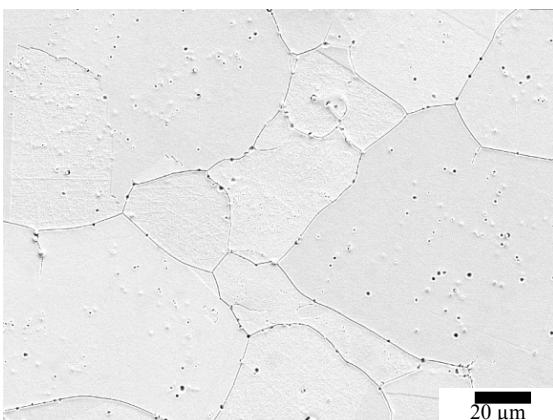
800°C



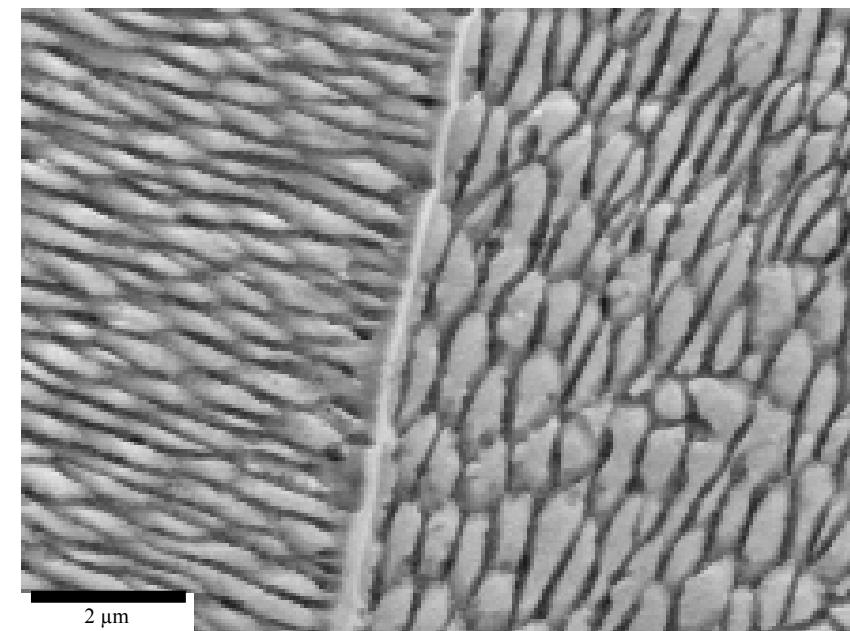
600°C



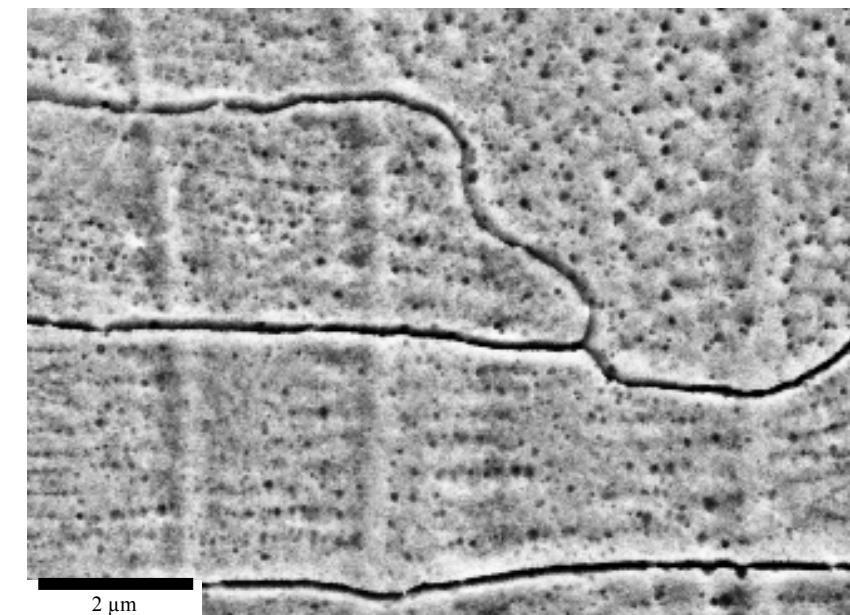
1200°C



600°C



800°C



- Changes in etching behavior indicate changes in cell boundaries
- Grain boundaries clearly visible after 800 C anneal, *does this indicate a change in chemistry or dislocation content?*
- Detailed TEM is necessary to understand the microstructural evolution that occurs during annealing at 800 C...