



### Questions

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

### Approach

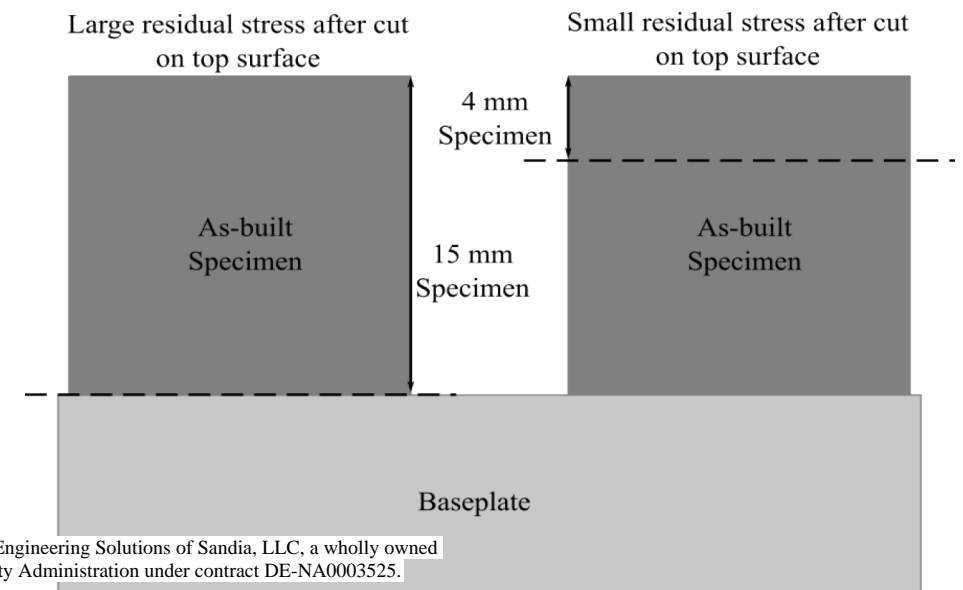
Control residual stress of powder bed fusion specimen with cutting/heat treatments.  
Assess SCC behavior through boiling  $\text{MgCl}_2$  exposures (ASTM G36-94)

***Presented by:***

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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”





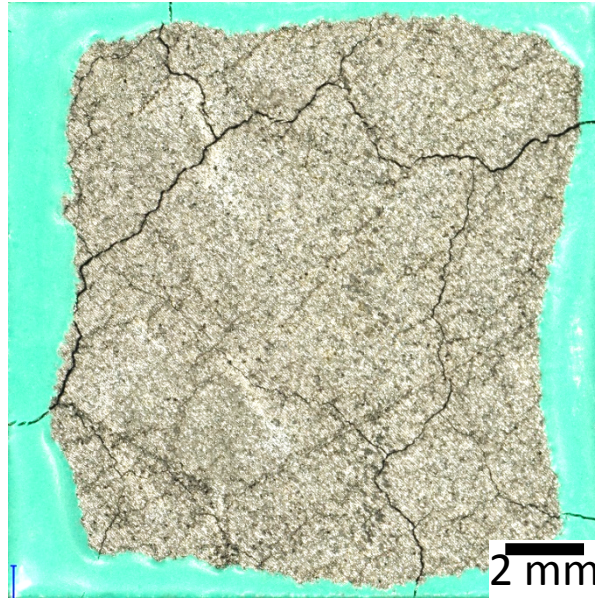
# How do residual stress and microstructure affect SCC susceptibility in LPBF 316L SS?



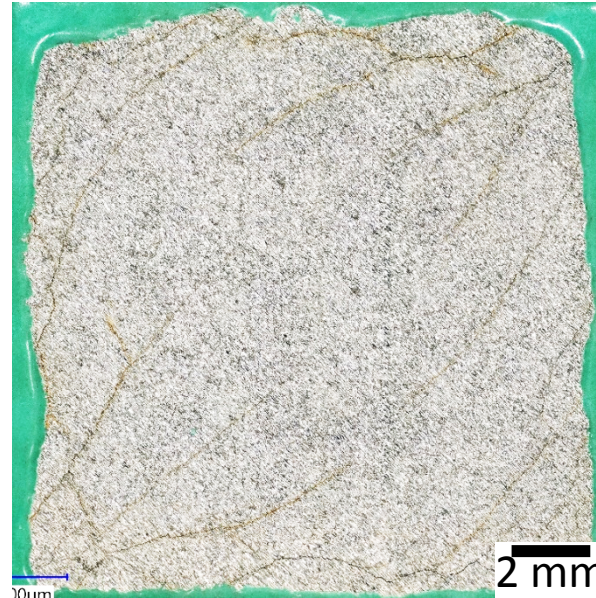
## Average Res. Stress, $\sigma_{xx}$ (MPa)

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

15 mm tall



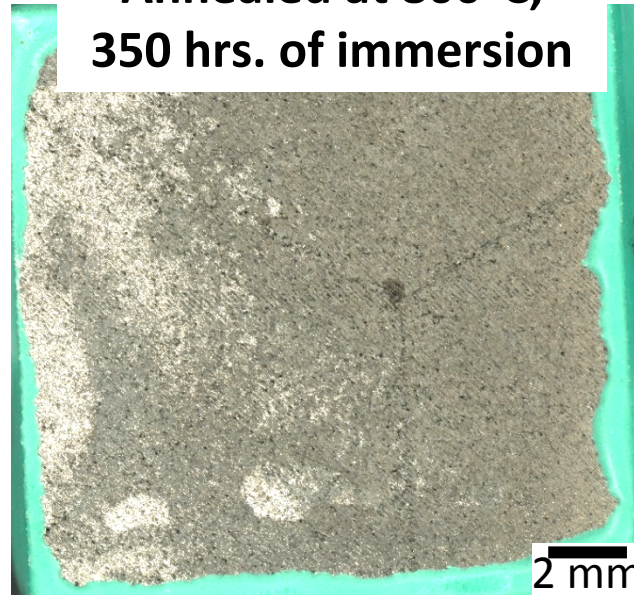
4 mm tall



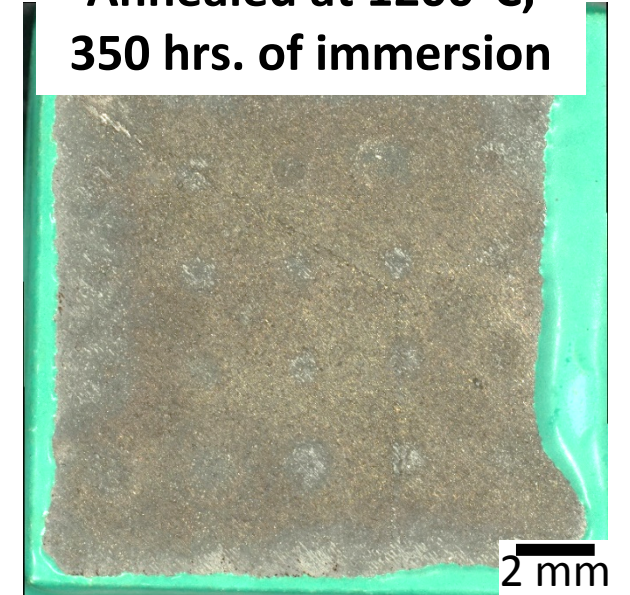
Annealed at 600°C



Annealed at 800°C,  
350 hrs. of immersion



Annealed at 1200°C,  
350 hrs. of immersion



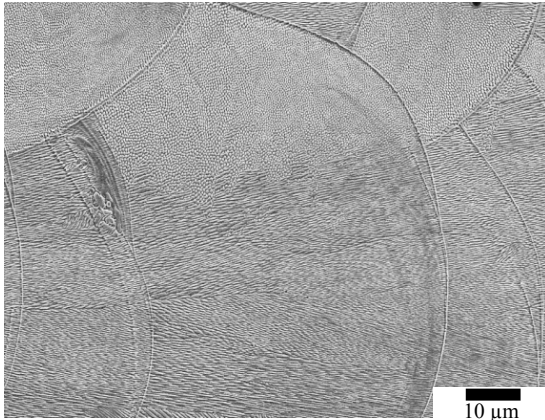
- Cracks observed in both 15 mm and 4 mm samples annealed at 600 C
- No cracks observed in 15 mm and 4 mm samples annealed at 800 C or 1200 C even though residual stress in 15 mm samples annealed at 800 C was greater than the as-built 4 mm sample!
- Microstructural evolution during annealing at 800 C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



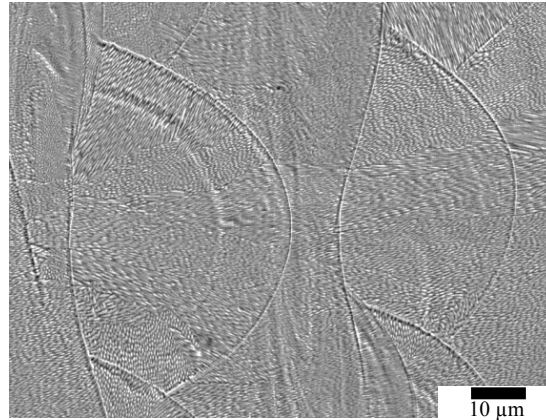
# How does annealing affect the microstructure?

3

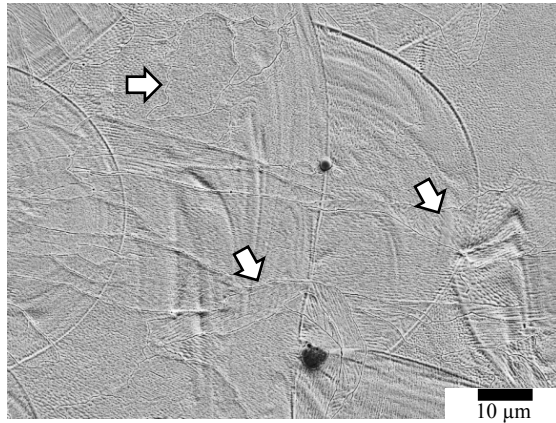
As-printed



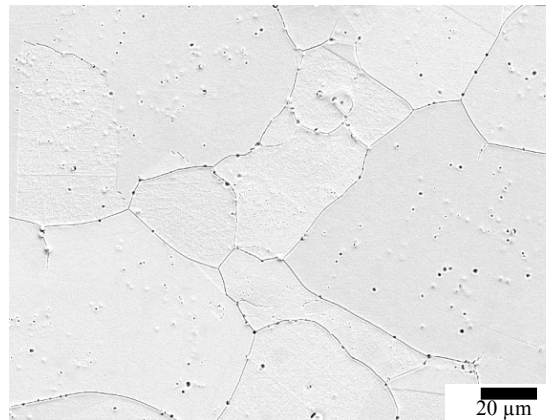
600°C



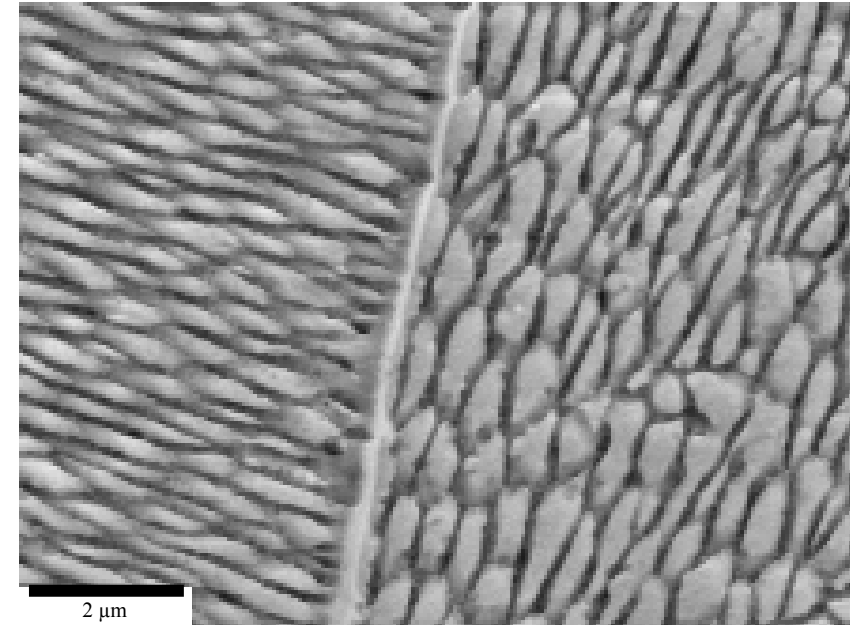
800°C



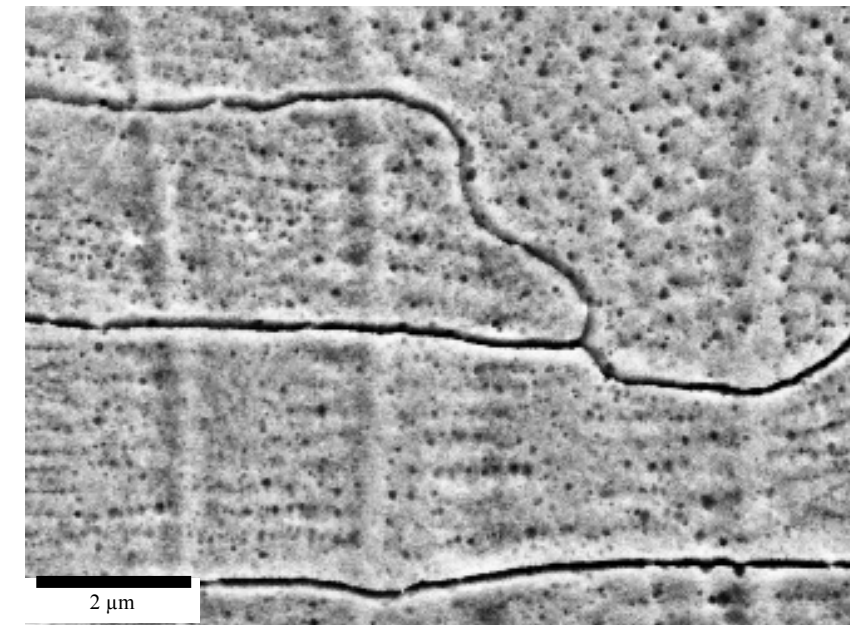
1200°C



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...