Characterization of the Microstructure of SLM IN718 Under Extreme Environments
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Introduction
The SLM processing of Inconel 718 holds great promise for the ease of manufacturing of turbine blades that withstand extreme temperatures, heat fluxes and high mechanical stresses associated with engine environments. The complexity of these extreme operational conditions demands precise knowledge of failure initiation within the material.

Motivation & Background

Solvus & 1

Objective
- Investigate variation in phase composition along build direction as a result of SLM process
- Observe in-situ high temperature microstructure evolution
- Characterize role of heat treatment
- Quantify residual stress and strain in as processed and heat treated SLM IN 718

Experimental Setup
(A) Selective Laser Melting (SLM) processing of samples
IR Heater
Sample
High Energy
X-ray

Variation with Build Direction
Sample 4 exhibits a microstructure closer to wrought IN718 (S). Greater volumes of precipitates in Sample 1 reflect the growth near the baseplate.

Effect of Heat Treatment
Heat Treatment: 1100°C for 1 hour, quenched and hardened at 720°C for 1 hour and 620°C for 1 hour, 1100°C for 1 hour and quenched
- High 6 precipitation is a result of SLM process
- Heat treatment can affect concentration of 6, but does not eradicate it completely
- Solvus temperature conditions may not apply
- As processed samples are weaker than wrought IN 718
- Extended exposure to high temperature strengthens SLM IN718

Future Work
- Calculate volume fraction based on intensity
\[ V_{\text{ax}} = \frac{I_{(hkl)\alpha}u^{2}}{\int F_{(hkl)\alpha}L_{\text{PP}}(u^{2})m_{(hkl)}I_{0}^{2} \text{d}u^{2}} \]
- Find phase volume fraction for each scan and establish phase volume evolution due to exposure to high temperatures

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References