**Abstract:** Ni Alloy 230, a commonly used aerospace alloy, often develops cracks during Direct Metal Laser Sintering. This project shows that cracks appear to be the least at an energy density of ~ 70 J/mm². New composition with lower Si and Mn showed significantly reduced cracking and abundant γ precipitates. The cracks may arise from grain boundary liquation along the γ phase, or through thermal stress gradients induced intergranular cracking.

**Methods**

**Porosity (Crack Density)**
- Porosity quantitatively defines the amount of cracks in each sample.
- Optical/SEM images were used to calculate the porosity.
- XRD
  - XRD performed on a D8 Focus Bruker, 30° to 60°

**Hardness**
- Alloy 230 – B (Hardness = 64.7 ± 0.92 HRA) exhibited higher hardness and lower crack density than Alloy 230 – W (Hardness = 62.5 ± 0.34 HRA).
- The suspected γ observed in the 230-B is believed to be a possible strengthening mechanism.
- The size distribution of the precipitates show the precipitates near the grain boundaries tend to be larger than the precipitates in the γ matrix.

**Conclusions**
- The cracks propagated along the grain boundaries as intergranular cracking. Two possible cracking mechanisms are:
  - Thermal stress on brittle γ phase during printing/cooling of the alloys
  - Grain boundary liquation from the low melting point in the grain boundaries propagating along the γ phase
  - The W segregation near the cracks is an indication for the liquation mechanism.
- Alloy 230 – W exhibited cracking and low hardness most likely due to chemistry.
- Studies of Alloy 230 – B and Alloy 230 – C suggest that a low Si and Mn composition (Alloy 230 – B) may lead to less cracking.
- Alloy 230 – B showed an overall smaller porosity than Alloy 230 – W, thought to be caused by the differences in Si and Mn.
- Alloy 230 - B contains regular precipitates.

**Recommendations**
1. TEM and WDS can be conducted to understand the chemical composition of the precipitates and matrix and to categorize the morphological structure of precipitates.
2. Perform EBSD to analyze the effects of texture on the precipitates.
3. Simulate a Ni-Cr-W ternary phase diagram to have a better understanding on the phase stability of the alloys.

**References**
[2] Bauer, T., Dawson, K., Spierings, A.B., Wegener, K., (N/A)..

**Investigation of Cracking in 230 Ni Alloy Prepared by Direct Metal Laser Sintering**

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