58: Understanding Microstructure Evolution of High Temperature Ni Alloys Across Additive Manufacturing Processes

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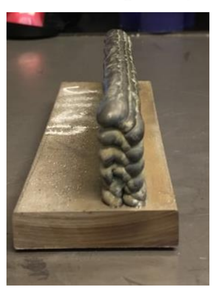
An Industry/University Cooperative Research Center

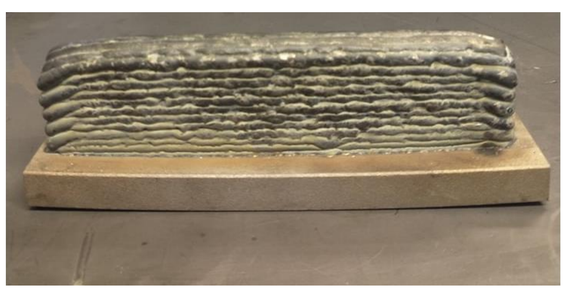
Industrial Relevance

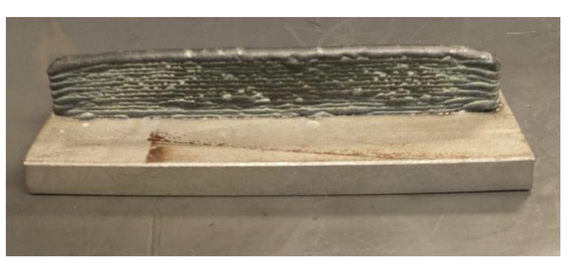
- Additive Manufacturing (AM) processes are being considered for production of structural components for Power generation applications.
- AM has allowed onsite fabrication of power plant replacement parts, preventing power plant outages and that are expensive and deteriorate the robustness of the energy infrastructure.
- Understanding the effect of AM on the microstructure of Ni based alloys will open doors to improve the quality of manufactured components.
- The annealing behavior of two Ni based alloys, Inconel 625 and Haynes 282, manufactured with Wire arc Additive Manufacturing (WAAM) and Laser Powder Bed Fusion (LPBF) is explored in this work.

Methods

- Single bead and multiple beads thick WAAM walls were manufactured using a collaborative robot (cobot) controlled Fronius CMT GMAW.
- LPBF samples were fabricate using a SLM Solutions 280
- Annealing was performed at 1000, 1100, and 1200 °C for 1 hour

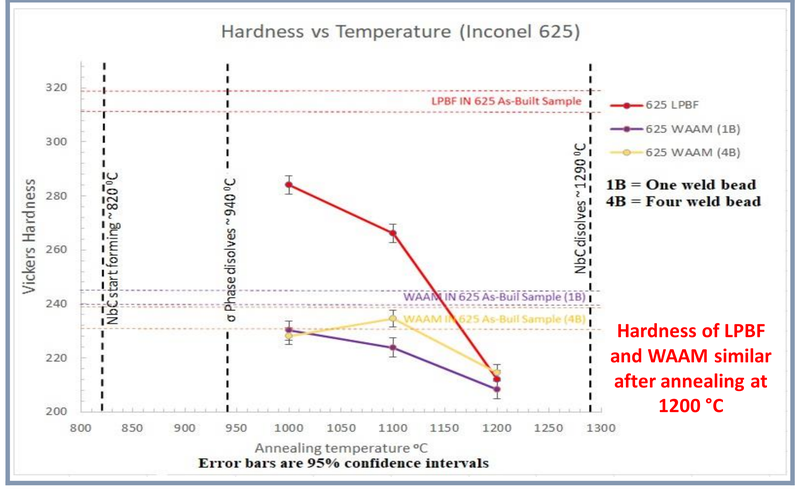






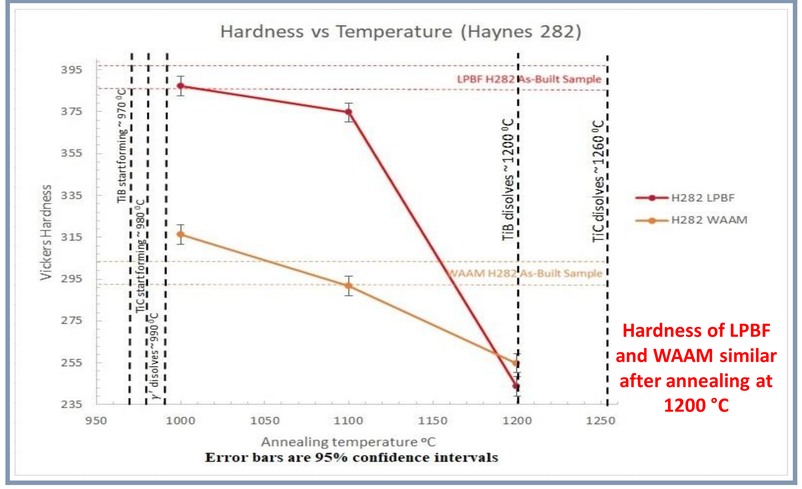
Recent Progress

Inconel 625



Hardness of LPBF and WAAM similar after annealing at 1200 °C

Haynes 282



Hardness of LPBF and WAAM similar after annealing at 1200 °C

- Recrystallization in LPBF IN625 and H282 samples occurred at 1200 °C, which is below the highest carbide solvus in each alloy.
- No recrystallization was observed any WAAM samples.
- The hardness of LPBF and WAAM specimens of both alloys are similar after annealing at 1200 °C despite considerable differences in microstructure.
- Differences in stored energy between LPBF and WAAM have a bigger effect on the annealing behavior than equilibrium precipitates in the material.
- The results suggest that WAAM microstructures are more stable during annealing and may also be more stable during extended high temperature service.

Future Work

- Evaluate the influences of grain size and morphology on the kinetics of σ phase formation during long term exposures at 650 °C and any resulting embrittlement in austenitic stainless steels (316L, 316LSi, 316H, 16-8-2) processed with WAAM.