**Introduction**

- The precipitation hardened 718 superalloy is composed of (55%Ni) (21%Cr) (11.15%Fe) (3.3%Mn) (5.5%Nb) (1%Cb) (.8%Cu) (1.15%Al) (< .5% Mn, Ti, Si, C, S, P, B)
- 718 Alloy’s high temperature strength is developed by precipitation strengthening, small amounts of niobium combine with nickel to form the intermetallic compound Ni₃Nb or gamma prime (γ’) that inhibit slip and creep effectively at elevated temperatures.
- 718 Alloy is preferable for use in aircraft and industrial gas turbine components because of its advanced high-temperature properties.
- 718 Alloy is often used in the cast form given the cost-effectiveness, components suffer damage during service because of the severe operating conditions.
- Repair of these components is often performed by welding or laser deposition (LD) processes, fusion repair of these cast superalloy components is extremely challenging because of its high susceptibility to liquation and cracking in the heat affected region (HAZ) of the weld along grain boundaries.
- Friction stir processing (FSP) is performed to reduce grains size and prevent liquation during laser cladding repair.

**Procedures**

- Friction stir processing of cast Inconel 718 (200 RPM, 2 IPM, 5000 lbf)
- Laser deposition of Inconel 718 powder on as-cast and FSP’d material at 500 W, 700 W, and 900 W
- Grinding and polishing – Up to 1200 grit, followed by 9, 6, 3, 1, 0.5 μm diamond suspension solution
- Etch – Walker’s Etchant: 50ml HCl, 10ml H₃PO₄, 10ml HF, 30ml HNO₃, 50ml H₂O, 20ml CHCO₂H, 15g FeCl₃
- Micrographs taken with Nikon Epiphot 200 optical microscope
- Vicker’s Hardness Testing, 1 kg load
- Vacuum tube furnace run under argon atmosphere for PWHT following AMS5383E, Section 3.5 specification: 2000 °F, 2 hours, and forced air cooling, 1750 °F, 1 hour, and forced air cooling, 1325 °F, 8 hours, furnace cool to 1150 °F at 100 °F per hour, hold 8 hours, and force air cool.

**Results**

- Deposition is affected by varying heat input
- Friction Stir Processing greatly reduced grain size

**Conclusions**

- FSW is successful in reducing grain size to prevent liquation cracking.
- The hardness values in the laser deposition region of 718 alloy show significant increase when the PWHT has been performed. This is significant because it shows the strength in the LD region can be recovered after treatment.

**Future Work**

- Further grain size analysis on PWHT samples is necessary to determine grain growth.
- Further Mechanical and Microstructural characterization to see if this would be an applicable repair technique.