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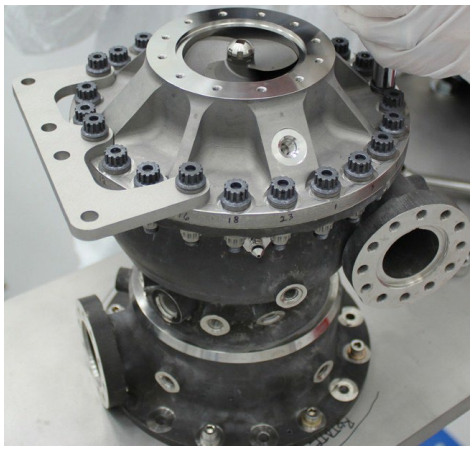
Characterization of Additive Manufactured Metals (CAMM)

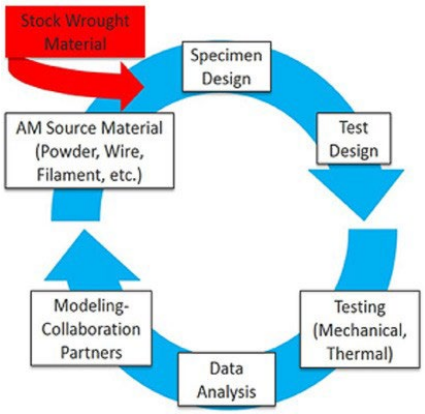


Kratos SRE has been building technical capability in developing and understanding manufacturing variability associated with additive processes so the technology can be integrated in more critical applications such as power generation, propulsion systems for aerospace, and space habitats for planetary exploration. Kratos SRE's Characterization of AdditiveManufactured Metals (CAMM) program compares conventionally fabricated with Additively Manufactured (AM) material in a way that considers process variation in the specimen and test designs.

Advancing these characterization efforts will develop a materials database of key process variations which will provide feedback for advanced processing solutions as well as predictions of material behavior modeling. Ongoing research includes low-cost NDE solutions and correlations to material properties.

- ***CAMM Process***

  A range of metal materials are being explored, including Inconel 718 and Ti-6AL-4V. The program focuses on mitigating parasitic stresses from build imperfections. Using cutting edge technologies, the study is contrasting AM versus wrought key properties, such as Poisson's ratio atelevated temperatures.



KratosSRE@KratosDefense.com 205.581.2412 www.KratosDefense.com

Nondestructive Characterization

- Nondestructive material property measurement
  - › Density
  - › Open porosity
  - › Ultrasonic evaluation
  - › Electrical resistivity
- Material inspection
  - › Ultrasonic inspection including pulse echo, c-scan and UltraSpec®
  - › Radiography
  - › Dye penetrant
  - › Eddy current
- Dimensional metrology and surface characterization
  - › Dimensional measurements across a range of temperatures
  - › Coordinate-Measuring-Machine (CMM)
  - › Surface profiling
  - › Microscopy (optical, SEM and TEM)

Mechanical Characterization

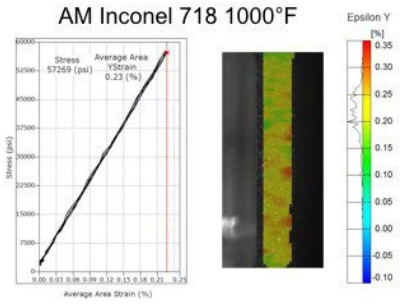
- Cryogenic, ambient and elevated temperature specimen design, characterization, and correlation to NDE and measured process parameters
  - › Tension
  - › Stress rupture/creep
  - › Fatigue
  - › Fracture toughness
  - › Geometric analog testing

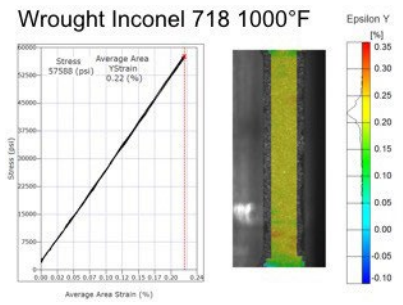
Digital Image Correlation

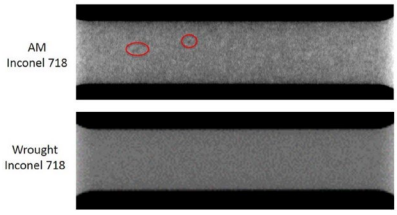
- Non-contact optical measurements
- Strain visualizations (localized and bulk statistics)
- Ability to capture strains RT—2500 °F
- Poisson's Ratio

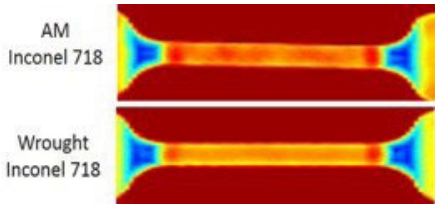
Thermal Characterization

- Physical property characterization through temperature range
  - › Thermal expansion
  - › Thermal conductivity
  - › Specific heat









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