NASA SBIR 2017 Phase I Solicitation

Z3.01 In-Situ Sensing of Additive Manufacturing Processes for Safety-Critical Aerospace Applications

Lead Center: MSFC

Participating Center(s): ARC, GRC, LaRC

Technology Area: TA12 Materials, Structures, Mechanical Systems and Manufacturing

NASA programs are embracing Additive Manufacturing (AM) technologies for their potential to increase the affordability of propulsion parts and components by offering significant schedule and cost savings over traditional manufacturing methods. Many NASA programs baseline AM components in their design, however qualification efforts are complicated by the absence of industry-accepted standards and process controls. The near-term methodology for part quality assurance is to use pre-process and post-process measurements to show that a part design and as-built hardware meet the established requirements to safely and reliably complete the intended mission. This method relies heavily on the ability to non-destructively evaluate parts to identify process escapes resulting in flaws in the AM parts. For parts of complex geometry, which is often the motivation toward AM, post-build inspections can be limited. The long-term goal of part qualification is to "qualify as you go." This concept uses pre-process, in-process, and post-process measurements to demonstrate that a part will perform to requirements. Successful technology demonstration has the potential to reduce scrap rates, and the cost and quantity of post-build NDE required for part qualification.

The principal desired outcome of this subtopic is to develop reliable in-process sensing and monitoring technologies for powder bed fusion (PBF) AM processes to aid in the quality of processes used to produce critical components for aerospace applications. Current AM PBF technologies run with limited or no process feedback; therefore, the ability to rely on process control alone is limited and the ability to non-destructively inspect AM parts is critical to the flight rationale for fracture critical components. The ability to augment AM process controls with verifiable feedback regarding process stability and part quality will significantly reduce the risk associated with complex AM parts that cannot be readily inspected with available non-destructive evaluation methods. The objective of the subtopic is to support activities that provide a foundation for practical application of AM sensing and monitoring technology in the aerospace sector, and also enable and stimulate development and innovation within the topic area. Supported activities will be based on long-term vision and the immediate needs of NASA programs and projects.

Specific research objectives include:

- Sensing technologies for layer-by-layer quality confirmation.
- In-process monitoring and sensing to detect off-nominal process conditions or defects.
- In-process monitoring and sensing for melt pool characterization.
- Predictive modeling of system response to sensing-related process changes.
- Multi-physics modeling of AM process as related to monitored quantities.