NASA SBIR 2018 Phase I Solicitation

Z3.01 Advanced Metallic Materials and Processes Innovation

Lead Center: MSFC

Participating Center(s): JPL, LaRC

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

This subtopic addresses specific NASA needs in the broad area of metals and metals processes with the focus for this solicitation on solid state welding, additive manufacturing, and processing of specialty materials including bulk metallic glasses and nano-crystalline metallic alloys.Â

Solid State Joining

Topic areas for solid state welding revolve around joining metallic materials preferably using solid state welding processes such as friction stir, thermal stir, and ultrasonic stir welding. Higher melting point materials of interest include the nickel based super-alloys such as Inconel 718, Inconel 625, titanium alloys such as Ti-6Al-4V, GRCop, and Mondaloy. Lower melting point materials of interest include Aluminum alloys such as 2195 and 2219.Â Â The technology needs for solid state welding should be focused on process improvement, structural efficiency, quality, and reliability for propulsion and propulsion-related components and hardware.Â

For the 2018 solicitation, the solid state joining focus is:Â

- Advances in process control, temperature monitoring and control, closed loop feedback, and implementing changes to the process parameters such as temperature, power, welding speed, etc.
- Monitoring and controlling processing parameters in real time in order to make quality, defect-free weld joints with desired and optimal grain morphology, mechanical properties and minimal distortion.
- Innovations in in-situ diagnostic and non-destructive testing technologies for solid state welding.
- Decoupling of the stirring, heating, and forging process elements characteristic of thermal or ultrasonic stir welding to achieve greater process control.
- Solid state welding of aluminum alloys plates of thicknesses greater than Â½ inch.Â

Additive Manufacturing

Several NASA programs are embracing metallic Additive Manufacturing (AM) technologies for their potential to increase the affordability of aerospace components by offering significant schedule and cost savings over traditional manufacturing methods. This technology is rapidly evolving and a deeper understanding of the process is needed to support hardware development and the use of AM hardware. For this subtopic AM topic area needs are concentrated on advancing the state of the art for the development powder bed fusion and/or directed energy deposition processes.

For the 2018 solicitation, the AM focus is:Â

- Surface finish improvements for internal and external AM components targeting a goal of 32 RMS; approaches may include in-situ process modifications to achieve better surface finishes directly from the AM machine, or secondary finishing approaches. The impact on total cycle time and cost from CAD to final part should be assessed as part of the justification for the approach proposed. The goal of work supporting this area is to help build the knowledge needed to support development of AM hardware.
- Development of hardware and/or process modifications to eliminate distortion and thermal residual stresses in as-built AM parts.
- Development of hardware and software tools that enable integrated CAD-to-part digital data capture, comparison, and archival for maintaining a â€œdigital twinâ€ correlation between parts and CAD design, slicing and tool path programming, in-process build information, secondary processing, and inspection data to document a traceable pedigree on parts.**Â**

Specialty Metals

In the specialty materials processing area, the focus for this solicitation is on bulk metallic glasses (BMG) and nano-crystalline metallic alloys. Specific areas of interest relate to optimized processing to fabricate these materials while retaining their unique microstructures and properties.Â

Specialty Metals: Nano-crystalline

Grain-size strengthening is a well-known phenomenon in metallic materials. The challenge for engineering applications has been maintaining ultrafine-grained microstructures in bulk materials.Â Processes that can demonstrate the production of stable, nano-grain structures without negative performance impacts are of interest. Exploiting these high-strength microstructures will enable new applications within NASA. One such application of interest is thin-walled structures, such as composite overwrapped pressure vessels (COPVs), where traditional material grain sizes approach the thickness of the part (< 25 grains through the wall). This leads to design challenges and concerns for fracture and fatigue properties. Ideally, nano-grained alloys with sufficient strength, ductility, and fracture/fatigue properties can be used to overcome design issues in thin-gage components.Â

For the 2018 solicitation of specific interest for nano-grained metallic alloys are innovative processing methods that:Â

- Produce bulk materials with grain sizes in the nanometer range for alloys of interest to NASA application (e.g., structural Al and titanium alloys).
- Ensure that these nano-grained structures are stable during:Â Â
    - Relevant thermal exposures experienced inÂ aerospace applications of interest to NASA and meet typical property requirements for those applications, and/or,Â Â
    - post-fabrication heat treatment, if necessary to develop suitable properties, and/or,Â Â
    - incorporation into end use items via additive manufacturing methods.**Â**

Specialty Metals: Bulk Metallic Glass

Of specific interest for BMGs are innovative processing methods for rapid prototyping of net shape bulk metallic glass components. Product forms of interest are uniformly thin walled structures, structures of high dimensional accuracy and precision (from nm to cm scales), and structures with features larger than the critical casting thickness of the BMG alloy but still amorphous. Consideration must be given to the availability of BMG feedstocks or accommodating the raw materials for in-situ alloy fabrication. Any approach should demonstrate control of contaminant elements (e.g., oxygen and carbon) or show an immunity to their presence.

For the 2018 solicitation of specific interest for bulk metallic glasses are innovative processing methods that:

- Rapid prototyping, while maintaining high dimensional accuracy.
- Uniform thin walled structures, that again, retain high dimensional accuracy.
- BMG structures with features that are larger than the critical thickness, but still amorphous.

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