NASA SBIR 2008 Phase I Solicitation

A2.01 Materials and Structures for Future Aircraft

Lead Center: GRC

Participating Center(s): AFRC, ARC, LaRC

Advanced materials and structures technologies are needed in all four of the NASA Fundamental Aeronautics Programs research thrusts (Subsonic Fixed Wing, Subsonic Rotary Wing, Supersonic, Hypersonic) to enable the design and development of advanced future aircraft. Proposals are sought that address specific design and development challenges associated with airframe and propulsion systems and should be linked to improvements in aircraft performance indicators such as vehicle weight, noise, lift, drag, lifetime, and emissions. The technologies of interest cover five research subtopics:

Fundamental Materials Development, Processing and Characterization

- Multifunctional materials and structural concepts for engine and airframe structures, such as, novel approaches to mitigating lightning strike, aircraft engine fan cases with integrated acoustic treatments and ballistic impact resistance.
- Adaptive materials and structural concepts for engine and airframe structures, such as shape memory alloys and polymers for active and highly flexible airframe and engine components, piezoelectric ceramics and polymers for self-damping engine and airframe components, materials and structures with integrated self-diagnostic, self-healing and actuation capabilities.
- Advanced high temperature materials for aircraft engine and airframe components and thermal protection systems, including advanced blade and disk alloys, ceramics and CMCs, and coatings to improve environmental durability.
- Innovative processing methods to reduce component manufacturing costs and improve damage tolerance and reliability, including processing and joining of ceramics, metals, polymers, composites, and hybrids, as well as nanostructured and multifunctional materials and coatings.
- Innovative methods for the evaluation of advanced materials and structural concepts (in particular, multifunctional and/or adaptive) under simulated operating conditions, including combinations of electrical, thermal and mechanical loads.

Structural Analysis Tools and Procedures

- Design methods for advanced materials and structural concepts (in particular, multifunctional and/or adaptive components) including variable fidelity methods, uncertainty based design and optimization methods, multi-scale computational modeling, and multi-physics modeling and simulation tools.
- Rapid design methods for airframe structures.
- Prediction tool for advanced engine containment systems, including multifunctional approaches.
- Integrated structural design and analysis methods for advanced composite materials.

- Design, development, analysis, and verification methods for structural joining technologies for high-temperature composite airframe and propulsion structures including bonding, fastening, and sealing.

Computational Materials Development Tools

- Computational materials tools for the development of durable high temperature materials.
- Computational tools to predict materials properties based upon chemistry and processing for conventional as well as nanostructured, multifunctional and/or adaptive materials.

Advanced Structural Concepts

- Innovative structural concepts and materials and/or robust thermal protection systems leading to reliable, high-mass planetary entry, descent and landing systems including deployable heat shields, high temperature films and fabrics.
- Improved thermal protection systems using innovative structural and material concepts, including structurally integrated multifunctional systems.
- Advanced mechanical component technologies including self lubricating coatings, oil-free bearings, and seals.
- Advanced material and component technologies to enable the development of a mechanical and electrical drive system to distribute power from a single engine core to drive multiple propulsive fans, in particular, AC-tolerant, low loss (< 10 W/kA-m) conductors or superconductors for the stators of synchronous motors or generators operating at > 1.5 T field and 500 Hz electrical frequency; and high efficiency (>30% of Carnot), low mass (<6kg/kW input) cryo-refrigerators for 20 to 65Â°K (lower efficiencies and mass-per-input-power that give the same or better refrigeration and mass are acceptable). Input power between 10 and 100 kW is envisioned in applications, but scalable small demonstrations are acceptable.

Durable Structural Sensor Technology for Extreme Environments (>1800Â°F)

- Development and validation of advanced high-temperature sensor technology to measure strain, temperature, heat flux, and/or acceleration of structural components.
- Development and validation of improved sensor bonding methods (i.e., adhesives, plasma spraying techniques, etc.) for attaching structural sensors on advanced high-temperature materials.