Advanced materials and structures technologies are needed in all four of the NASA Fundamental Aeronautics Programs research thrusts to enable the design and development of advanced future aircraft. In general, technologies of interest that cover the four research thrusts (Subsonic Fixed Wing, Subsonic Rotary Wing, Supersonic, Hypersonic) include:

- Fundamental materials development and characterization;
- Multifunctional materials and structures development;
- Life prediction and damage modeling;
- Validated structural analysis tools; and
- Computational materials development tools.

More specific information on materials and structures technologies of interest in this program is given below.

### Subsonic Fixed Wing Aircraft

Proposals are sought that address specific design and development challenges associated with airframe and propulsion systems and directly support improvements to future subsonic fixed wing aircraft. The potential impact of the proposed technologies should be linked to improvements in aircraft performance indicators such as vehicle weight, noise, lift, drag, lifetime, and emissions. Specific technology areas where contributions are sought include, but are not limited to, the following:
• Advanced materials design concepts and processing development (e.g., multifunctional materials concepts, innovative approaches to damage tolerant lightweight structural materials, lightweight materials concepts to mitigate lightning strike damage, hybrid materials approaches to multifunctionality and/or improved durability and damage tolerance, and high-temperature materials for propulsion system applications);

• Design methods for material and structural concepts (in particular, multifunctional concepts) including variable fidelity methods, uncertainty based design and optimization methods, multi-scale computational methods, and multi-physics modeling and simulation tools;

• Adaptive materials and structures concepts (e.g., environmentally responsive materials and structures, intrinsically load/strain sensing materials and structures, active and/or highly flexible structures, shape memory and self-healing materials, innovative non-parasitic in situ methods to detect damage, impact and structural dynamics);

• Concepts and techniques for advanced multifunctional and/or adaptive material and structures characterization and evaluation (including combinations of thermal and mechanical loading environments);

• Identification, development and verification of degradation and failure mechanisms/criteria, residual strength (and other critical residual properties) and life prediction methods, and damage science design and analysis methods;

• Advanced materials fabrication and processing methods and joining and assembly methods, for ceramics, metals and polymers and/or hybrids of these materials;

• Tribological surface sciences, and mechanical components including oil-free bearings, seals technologies, and mechanical and electrical drive system to distribute engine power from a single engine core to drive multiple fans.

Supersonic Aircraft

Supersonic aircraft require durable and reliable materials and structures to provide continuous operation at speeds in excess of Mach 2. Specific technology areas where contributions are sought include:

• Oxidative fail-safe CMC, CMC structures for liners and airfoils;

• Advanced engine containment prediction tools;

• High temperature shape memory alloys;

• Accelerated life prediction tools;

• Rapid design methods for aircraft structures;

• Novel hot acoustic absorber technologies are also of interest to address the sound problems with supersonic flights.
Hypersonic Vehicle

The ultra-high temperatures and extreme environments experienced by a hypersonic or re-entry vehicle requires advanced materials and structures technologies to enable safe reliable vehicle operation. Specific technology areas where contributions are sought include:

- Physics-based life prediction methods for advanced high-temperature composites that support integrated structural design and analysis methods;
- SQL based software development tools for advanced material design database management;
- Advanced thermal protection systems using innovative structural and material concepts to improve vehicle safety and decrease weight including structurally integrated multifunctional systems;
- Advanced technology for enhanced thermal management, self sensing, and self healing of high-temperature materials;
- Design, development, analysis, and verification of advanced structural joining techniques for high-temperature composite airframe or propulsion structures;
- Computational materials development tools for durable high-temperature materials;
- Development of composite material systems and coatings for significantly improved hypersonic environmental durability for increased mission lifetimes;
- Development of durable structural sensor technology for extreme environments (> 1800 °F);
- Innovative structural concepts and materials leading to reliable high-mass planetary entry, decent, and landing systems.