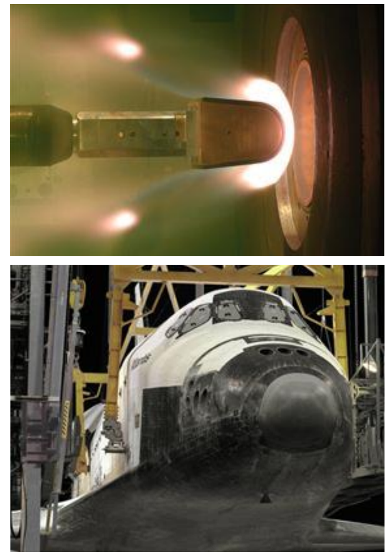
Thermal Protection Systems Development

The U.S. Air Force and other Government agencies are developing design concepts for far-term reusable hypersonic vehicles for a wide range of missions. These future vehicles will fly faster and longer than the reusable vehicles currently being developed, and at quicker operational tempos and with hundreds of missions prior to major refurbishment. As a result, these vehicles will require thermal protection systems (TPS) capable of withstanding hours of exposure to extreme temperatures and thermochemical states that aggressively attack many of today's advanced high-temperature materials.

Space access vehicles have typically utilized "parasitic" TPS where sacrificial materials, such as the tiles used on NASA's space shuttles, are attached to the outer surfaces of the vehicles to endure large thermal loads. Parasitic TPS protect the cold, load-carrying airframe structure but add significant weight, limiting vehicle range and payload. Reusable hypersonic vehicles ideally will utilize "hot structures" where the thermal management capabilities are integrated into the load-carrying airframe structures, reducing system weight and enhancing performance and mission reliability. For far-term vehicles, these hot structures must also provide significant durability and resistance to thermochemical degradation.



Load-bearing TPS offer significant advantages over "parasitic" TPS

Carbon/carbon structures are being considered for hot structure use since the material maintains strength at elevated temperatures and resists the extreme environments of high-speed flight. However, much scientific and technical work remains to explore the high-speed vehicle capabilities of carbon/carbon and associated coatings, identify non-destructive inspection techniques, study the initiation and progression of material damage in severe flight environments, and transition the technology into advanced load-bearing TPS.

The University of Dayton (UD) is a top ranked university in federally sponsored R&D in materials, with significant experience developing, modeling, characterizing, and processing carbon/carbon and similar high-temperature material and design concepts. The University of Tennessee (UT) offers unique capabilties to simulate the detailed thermal, chemical, and structural response of a material or design concept exposed to the complex environment in which TPS must operate, and to experimentally validate the simulations through testing under relevant conditions. The UD/UT team will leverage their collective expertise and experience for carbon/carbon TPS development. Successful completion of the program will provide the Air Force with practical TPS solutions for future high-speed air and space vehicles.

Air Force Need: Accelerated development of advanced thermal protection systems

Program Scope:
- Characterization of relevant thermochemical TPS operating environment
- Development of efficient carbon/carbon TPS design concepts
- Fabrication and assembly of leading design concepts
- Experimental assessment of TPS performance under relevant conditions

Ohio Benefits: Establish WPAFB/Dayton as a center for thermal protection system development.

Tennessee Benefits: Expand Tennessee's position as a leader in testing high-speed systems with complementary research capabilities.

Requested Action: Authorization and Appropriation of an additional $10 million in FY 2021 in the Air Force RDT&E PE 602102F, Materials, to initiate the "Thermal Protection System Development" program and the following report language:

Advanced thermal protection systems development is needed to enable efficient operation of high-speed vehicles being developed for military and commercial aerospace missions. The committee provides an increase of $10 million to Air Force PE 602102F only for maturation of carbon/carbon thermal protection systems.

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