A1.10  Hypersonic/High Speed Technology - Seals and Thermal Barriers

Lead Center: GRC

Participating Center(s): LaRC

Technology Area: TA15 Aeronautics

**Scope Title**
Development of High Temperature, Wear-Resistant Coatings for Seals and Thermal Barriers

**Scope Description**
Future high speed vehicles will require high temperature, dynamic seals and thermal barriers around movable surfaces to minimize the ingestion of hot gases through sealed interfaces and protect underlying temperature-sensitive structures. Locations include around the edges and along the hinge lines of movable control surfaces (e.g., flaps, rudders), panels, and doors. The seals must operate in high heat flux, oxidizing environments and restrict the flow of hot gases at temperatures on the order of 2000° F. They must be flexible enough to accommodate distorted sealing surfaces while remaining in contact with them to create an effective seal. In some locations, they may also have to limit applied loads against sealing surfaces that are fragile or covered with delicate protective coatings. The seals must also be sufficiently durable to meet required life goals. They must resist damage as they are rubbed over rough, distorted sealing surfaces without incurring excessive increases in leakage due to wear. In some locations the seals may have to seal against rough thermal protection system (TPS) materials without sticking to their surfaces. Previous testing has shown that coatings on flexible fabrics can potentially improve seal durability. The objective of this opportunity is to identify and/or develop high temperature, wear-resistant coatings for seals and thermal barriers and evaluate their durability under representative operating conditions.

**References**

https://www.nasa.gov/aeroresearch/programs/aavp/ht

**Expected TRL or TRL range at completion of the project:** 1 to 5

**Desired Deliverables of Phase II**

Prototype, Analysis, Hardware, Research

**Desired Deliverables Description**

Deliverables include development, production, demonstration and evaluation of high temperature, wear-resistant coatings for seals and thermal barriers with key demonstrations/evaluations of their durability under representative operating conditions.
State of the Art and Critical Gaps

State-of-the-art seals and thermal barriers are often fabricated out of flexible, high-temperature ceramic fibers and fabrics to help minimize seal compression loads and to allow them to accommodate variable gap geometries and distorted sealing surfaces. However, these materials can become damaged when they are rubbed against adjacent sealing surfaces, especially in dynamic applications. This can lead to higher leak rates and increases in temperature near critical components thereby requiring the seals to be replaced, often after a limited number of missions.

Relevance / Science Traceability

This subtopic relates to the Hypersonics project within Aeronautics Research Mission Directorate (ARMD). Materials development is a long lead-time research area, and engaging innovation across a wider community through SBIR provides time to develop technologies that can be enabling for future hypersonic vehicles.

Scope Title

Development of High Temperature Elastomer for Use in Seal Applications at 700+°F

Scope Description

Future high-speed vehicles will require high temperature, low leakage seals to minimize the ingestion of hot gases through sealed interfaces and protect underlying temperature-sensitive structures (mostly static interfaces). The objective of this opportunity is to identify and/or develop a high temperature elastomer that can be formed (e.g., molded, extruded) into various seal geometries for use at temperatures of 700°F or greater. Upon successful identification/development of the elastomer, test specimens will be fabricated and evaluated under representative operating conditions.

References

https://www.nasa.gov/aeroresearch/programs/aavp/ht

Expected TRL or TRL range at completion of the project: 1 to 5

 Desired Deliverables of Phase II

Prototype, Analysis, Hardware, Research

 Desired Deliverables Description

Deliverables include development, production, demonstration and evaluation of a high temperature elastomer that can be formed (e.g., molded, extruded) into various seal geometries for use at temperatures of 700°F or greater with key demonstrations/evaluations of sealing capability under representative operating conditions.

State of the Art and Critical Gaps

Low leakage seals such as O-rings are often made of elastomers because these materials exhibit little plastic flow and rapid, nearly complete recovery from an extending or compressing force. However, even the most heat-resistant elastomers have maximum continuous use temperature limits of about 600°F. Current heat-resistant elastomers have maximum continuous use temperature limits of about 600°F at which point they begin to break down and cease to function as an effective seal.

Relevance / Science Traceability

This subtopic relates to the Hypersonics project within ARMD. Materials development is a long lead-time research area, and engaging innovation across a wider community through SBIR provides time to develop technologies that
can be enabling for future hypersonic vehicles.

**Note:** This subtopic solicits proposals in high temperature sealing needs which require, dynamic, static and/or barrier needs. Proposers working on hot structures should consider proposing to the H5.02 - Hot Structure Technology for Aerospace Vehicles subtopic in the Human Exploration and Operations Mission Directorate.