

Department of the Navy SBIR/STTR Transition Program

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Topic # AF171-020

Ytria-stabilized Zirconia Environment Sensing (YES) System for Hypersonic Glide Bodies
Innoveering, LLC

WHO

SYSKOM: SSP

Sponsoring Program: Strategic Systems Programs (SSP)

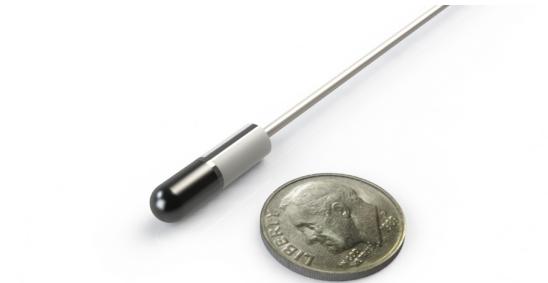
Transition Target: US Navy SSP

TPOC:

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Other transition opportunities:

Opportunities exist to transition to DoD and other government customers such as Navy Crane, AFRL WPAFB and other hypersonic wind tunnel operators and to commercial entities such as Lockheed Martin, Pratt-Whitney, Dynetics, General Atomics, Raytheon and GE. The sensor will be available as an integrated unit that in turn can be integrated into a test article. It is anticipated that customization of the sensor and its packaging to address integration requirements will be needed to maximize operational performance.



YES Sensor packaged in standalone probe configuration with size comparison to a US dime. Copyright Innoveering 2021

YES Sensor packaged in standalone probe configuration with size comparison to a US dime. Copyright Innoveering 2021

WHAT

Operational Need and Improvement: The ultra-harsh environments in hypersonic ground and flight testing require the instrumentation and probes to be water cooled and typically require frequent replacement, which can be costly and result in unnecessary facility downtime. In many instances, the probes supporting hardware or cooling designs may impact the actual flow measurement and introduce uncertainty. With the advent of advanced materials and novel thin-film manufacturing techniques, these challenges can be alleviated or even eliminated with the YES sensor technology. Real-time surface temperature and gas composition information can be obtained through the implementation of the YES sensor technology in environments of Mach 5 enthalpy and above, without the need for cooling.

Specifications Required: Miniature in size with ability to be integrated within advanced materials; No active cooling needed to survive extreme temperatures of Mach 5 and above flight environments; Multi-property sensing of temperature, oxygen concentration and pressure; High frequency response to accurately measure the dynamics associated with hypersonic flow time scales.

Technology Developed: A ceramic-based thin film micro-sensor that is capable of operating in extreme temperature environments, typical of hypersonic flight conditions. The sensor can measure directly flow temperature and oxygen concentration in the gas medium, and has a path to pressure measurement as well. It is surface mounted onto a wetted surface or packaged so that it can be integrated into a substrate, like a leading edge or other critical component where temperature and oxygen concentration are needed to be measured.

Warfighter Value: There is no sensor solution that can deliver on multi-property measurement at the ultra-high temperatures servicing hypersonic test articles. The benefits to warfighter are:

- A smaller sensor of < 1/4" outside diameter.
- Reliable operation in harsh hypersonic environments.
- Minimal flow perturbation (flush mounted or integrated).
- Direct temperature oxygen & partial pressure measurements.
- Dynamic data for more accurate hypersonic aero-propulsion performance/drag/thermal loads calculations.
- Sensor to measure skin temperature of a hypersonic air-breathing or boost-glide vehicle

WHEN

Contract Number: N68335-21-C-0070 **Ending on:** October 31, 2022

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Systems / Subsystems Specifications	Low	Submission and Review	3	TBD
Brassboard Systems Assembly and Demonstration	Low	Performance validation near adiabatic CH4/Air flame temperature in the laboratory	3	TBD
Prototype System Assembly and Demonstration	Med	Integrated system demonstration using Innoveering's hypersonic ground test facilities	5	TBD
Carbon-Carbon Composite Implementation	High	Fully integrated sensor node within CCC material and tested in hypersonic ground test facility	5	TBD
Relevant Hypersonic Test Demonstration	Med	Multi-property measurements in dynamic hypersonic flow environment, ground or flight.	6	TBD

HOW

Projected Business Model: Innoveering will scale and manufacture sensors in house and distribute the YES sensors with other sensors through standard aerospace distribution channels. We have personnel experienced in product realization for manufacturing and product commercialization to grow business opportunities. Software and sensor hardware will be produced and sold by Innoveering that can lead to potential DoD program savings if final sensor and hardware requirements and packaging are similar to other applications. Start-up costs, such as tooling and minimum production run needs, can possibly be shared by multiple programs. This not only shares costs, but also reduces program risks for design validation, as well as, ongoing production quality considerations. By identifying additional programs we will improve the likelihood of multiple revenue generation channels. Parallel revenue streams can be realized through sales to combustion and aero-propulsion ground test facilities, as well as other high temperature processing industries.

Company Objectives: We will pursue transition to DoD and other government customers such as Navy Crane, AFRL WPAFB and other hypersonic wind tunnel operators. In all cases we will strive to accomplish both types of Phase II graduation efforts. For non-licensed products that graduate from Phase II, Innoveering will establish a separate entity focused on the specific product family with its own revenue and funding streams. This is necessary to have a production-focused company Vision, Mission & Culture compared to the R&D-focused efforts of Innoveering.

Potential Commercial Applications: Potential harsh and high temperature environments include industrial furnaces, chemical reactors, metals processing, combustion based power plants, internal combustion and jet engines.

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