

Topic: N151-062

Physical Sciences Inc.

Electrochemically Assisted Safe Ionic Propellant

Conventional solid propellants are ignited once and cannot be extinguished, burning until zero propellant remains. However, this technology allows solid propellants to be ignited and extinguished on-demand using a novel solid propellant formulation and a reusable electrical igniter. This enables long-range divert and attitude control systems (DACS) to intercept hypersonic missiles fielded by near-peer adversaries. The propellant was demonstrated in ground-based hot-fire testing. Physical Sciences Inc. develops advanced technologies for the defense sector in optics, lasers, sensors, propulsion, and energetics. Targeted platforms consist of propulsion systems for missiles and interceptors including thrust control motors and dual-pulse rocket motors. Our ultimate goal is to obtain non-SBIR matching funds for flight demonstration of a 5 inch diameter motor, followed by full-scale Navy thrust control motors.

Technology Category Alignment:

Weapons Technologies

Space

None

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SYSCOM: ONR

Contract: N68335-17-C-0055

 Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-17-C-0055

 Tech Talk: <https://www.youtube.com/watch?v=f4YOFGFV5Og>

Department of the Navy SBIR/STTR Transition Program

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ONR Approval #

Topic # N151-062

Electrically-assisted, High Performance Extinguishable Solid Propellant for Advanced Thrust Control Motors
Physical Sciences Inc.

WHO

SYSCOM: ONR

Sponsoring Program: ONR S&T Office Code 35, Development and Transition of Weapon Systems Technology

Transition Target: SM-3 Stage 4 Throttleable Divert and Attitude Control System (TDACS)

TPOC:

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Other transition opportunities: Thrust control motors for Missile Defense Agency (MDA) Ballistic Missile Defense System (BMDS) Targets and Countermeasures. Small engines and thrusters for commercial spacecraft.

Notes: Photograph of PSI's gas generator test stand for hot-fire testing of SEHICS propellant.

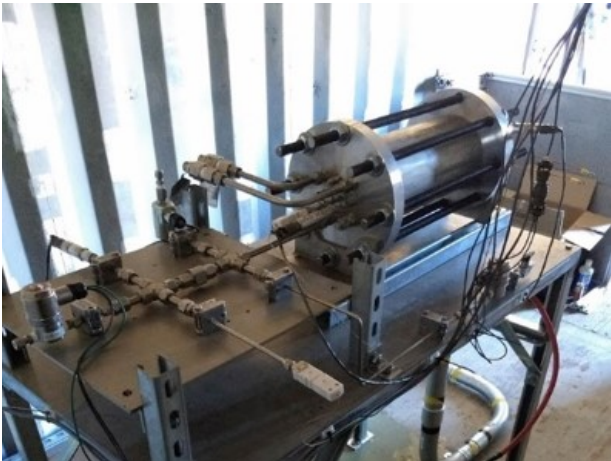


Image courtesy of Physical Sciences Inc. (PSI), 2019.

For every dollar of Phase II SBIR investment, PSI has secured nearly 3 times that dollar investment in Phase III funding.

WHAT

Operational Need and Improvement: Emerging threats from hypersonic weapons require advancement of the Navy's missile interceptors in order to maintain an effective missile defense system. An increase in range and agility of the Aegis Ballistic Missile Defense (BMD) system requires high performance propulsion systems that enable new methods for maneuvering towards enemy targets across a larger space. The solid propellant TDACS of the interceptor's kill vehicle must achieve longer flight paths and coast during periods between maneuvers. Upper stage motors and kick motors requiring increased range and agility demand novel methods for coasting and dual-pulse capabilities.

Specifications Required: An upgrade to the SM-3 TDACS must be done without increasing the mass or volume of the vehicle. The propellant's DOT Hazard Division must remain at 1.3 or less using a storable solid propellant and conventional solid propellant ingredients. The solid propellant gas generator must conserve propellant when divert or attitude thrusters are inactive.

Technology Developed: PSI's Self-extinguishing, High Specific Impulse, Controllable Solid (SEHICS) propellant is a unique solid propellant with a new chemical formulation and ignition system that allows the propellant to be repeatedly ignited and extinguished, allowing a propulsion system to be re-used with far more versatility for a wide range of missions. SEHICS uses conventional composite propellant ingredients in a novel formulation that is intentionally extinguished and re-ignited on-demand, enabling coasting and increased range. The SEHICS formulation maintains Insensitive Munition (IM) compliancy per MIL-STD-2105D.

Warfighter Value: Near-peer adversaries have proliferated the threat of tactical ballistic missiles, and using SEHICS propellant in an interceptor's TDACS augments the Navy's "lower-tier" (intercepts inside the atmosphere) and "upper-tier" (exo-atmospheric) abilities with greater coverage per interceptor. Dual-pulse rocket motors and variable thrust motors with extinguishable propellants can also be used to increase range and coverage.

WHEN

Contract Number: N68335-17-C-0055 **Ending on:** December 21, 2020

| Milestone | Risk Level | Measure of Success | Ending TRL | Date |
|--|------------|---|------------|--------------|
| Ground-based Gas Generator Test of Repeated ON/OFF | High | Multiple ON/OFF actions in a single automated test sequence with a 1 | 4 | 4th QTR FY20 |
| Ground-based Gas Generator Test of Propellant Scale-up | Med | Multiple ON/OFF actions with a 2 | 4 | 1st QTR FY21 |
| Validation in Flight-like 5 | Med | Successful replication of gas generator operation in a multi-nozzle DACS | 5 | 2nd QTR FY22 |
| Flight Test in 5 | High | Successful replication of ground-based ON/OFF operation during in-flight thrust maneuvers | 6 | 2nd QTR FY24 |

HOW

Projected Business Model: Our business model is to produce solid propellant when delivery quantities are within our energetics mixing capabilities at PSI. When large production quantities are needed for full-scale DACS or large motors (greater than 8 inch dia.) PSI partners with larger energetics manufacturers. PSI can meet low-rate initial production (LRIP) demands, but requires a manufacturing partner for full-rate production (FRP).

Company Objectives: We anticipate the Navy SBIR/STTR Transition Program (STP) will facilitate connections with Government and industry decision-makers in the propulsion community. Our short term objective is to earn non-SBIR matching funds (min: \$500,000) to enable Option 2 of our current Phase II contract. This initial funding installment allows a DoD program office to have low risk involvement before evaluating the benefits of a future Phase III program. The Phase II Option 2 program will validate the technology in a ground-based 5 inch dia. DACS in partnership with Valley Tech Systems Inc. (Folsom, CA). This demonstration completes the Phase II program and allows a 5 inch dia. DACS flight demonstration to occur in a subsequent Phase III program, bringing the TRL to 6. A flight-demo Phase III program will offer the data needed to insert the technology into spiral upgrades of large interceptors systems, such as the SM-3 kill vehicle, or establish entirely new DACS for Targets and Countermeasures.

Potential Commercial Applications: This technology would be applicable to commercial space propulsion applications, as well as any needs for a storable, reusable igniter for rocket engines, rocket motors, aircraft engines, and pyrotechnic devices.

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