Topic: N141-011

Helicon Chemical Company LLC

Advancements in Solid Ramjet Fuel Development

Helicon develops nanoparticle-polymer composites with superior properties for a wide range of applications, including energetic materials. Helicon's high-performance, insensitive fuels for solid fuel ramjet (SFRJ) systems contain in situ grown aluminum nanoparticles (nAl) formed directly in polymer solutions. Since SFRJ is a competitive solution for tactical systems requiring long range and high speeds, the technology is applicable to multiple weapons including hypersonic applications. Helicon is using efficient combustion of in situ nAl to produce fuels meeting the Navy's challenging performance requirements while remaining insensitive. Achievements include testing in a ramjet combustor, validating performance in a realistic prototype; and manufacturing process scale-up to support future large-scale testing. Our goal is to partner with primes and Navy weapon system program offices to further this effort.

Technology Category Alignment:

Materials & Manufacturing Processes
Weapons Technologies
Air Platforms

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SYSCOM: NAVAIR
Contract: N68936-17-C-0046

Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68936-17-C-0046

Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2020-861

Topic # N141-011
Solid Ramjet Fuel Containing In-Situ Grown Aluminum Nanoparticles
Helicon Chemical Company LLC

WHO

SYSCOM: NAVAIR

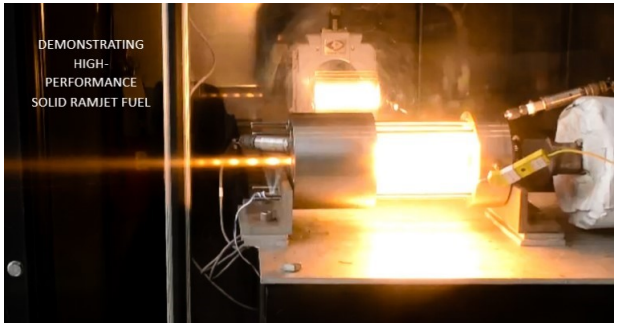
Sponsoring Program: PEO (T)

Transition Target: PMA 259, PMA 242, PMA 280

TPOC:
(760)939-7966

Other transition opportunities: Next generation extended-range artillery projectiles (Army)

Hypersonic missile development projects (DARPA - USAFB)



Current nanocomposite energetics focus areas of our DoD customers:

- 3D printable propellants
- Airbreathing propulsion
- Liquid fuels & propellants
- Insensitive Munitions
- Industrial base obsolescence
- Next-generation chemical propulsion systems
- Nanoenergetics programs at Navy, Army, Air Force

WHAT

Operational Need and Improvement: Solid Fuel Ramjets (SFRJ) demonstrate significant performance improvements over solid rocket-based propulsion for tactical systems requiring longer range and/or higher speeds. Their inherent high specific impulse values can lead to a 5-fold increase in range vs. a similarly sized solid rocket system. The U.S. Navy is seeking to develop solid fuels that combine high energy density and combustion efficiency to maximize the range and speed advantage obtained by SFRJ technology.

Specifications Required: The objective of this SBIR effort is to develop a solid ramjet fuel with a heating value of at least 825 BTU/in3, having a high regression rate with stable combustion in airbreathing rocket configurations, and a combustion efficiency greater than 90% over a wide range of operating conditions. Methods of increasing fuel-regression rates should not be at the expense of fuel inertness.

Technology Developed: Helicon is developing polymer-aluminum nanocomposite fuels for future SFRJ systems. These fuels combine high density, regression rate, combustion efficiency, and safety. These fuels contain in situ grown aluminum nanoparticles (nAl) produced by our unique method of growing particles directly in polymer solutions. Advantages of this method include:
(1) uniform, permanent dispersion in the polymer - ensures true nano-scale properties
(2) oxide free nanoparticles - enables highly efficient aluminum combustion
(3) no free nanoparticles - eliminates processing and handling safety issues of traditional nanomaterials

Warfighter Value: Helicon's advanced, high-performance, insensitive fuels will meet the challenging performance goals for future Naval weapons platforms, providing the improved range and reduced time to target required to defeat evolving threats. Helicon's revolutionary nanocomposite manufacturing process provides this performance advantage in a scalable, cost-effective approach compatible with current fuel production methods. Our fuels meet the "wooden round" Navy goal as the solid fuel grains are insensitive to inadvertent initiation from external hazards, such as bullet impact and thermal exposure.

WHEN

Contract Number: N68936-17-C-0046 **Ending on:** February 28, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Preliminary Airbreathing Combustion Small-scale Test	Med	Fuel performance improvement over a relevant baseline measured in a small-scale airbreathing combustor	TRL 3	April 2020
Fuel Formulation Downselect	Low	Fuel meeting program objective for energy content successfully tested in a small-scale airbreathing combustor	TRL 4	November 2020
Fuel Production Scale-up	Low	Kilogram scale material production capability achieved	TRL 4	December 2020
Subscale Direct-connect SFRJ Test	Med	Fuel performance improvement over a relevant baseline measured using 1 kg fuel grain and 10 second burn	TRL 5	February 2021
Phase II Option B: Full-scale Fuel Manufacturing Feasbility Demonstration	Low	Full-scale fuel grain produced	TRL 5	August 2021
Delivery of Fuel to the Navy	Low	3 kilograms of fuel ingredients delivered	TRL 5	August 2021

HOW

Projected Business Model:
Helicon's technology is the set of fuel ingredients that enable the required performance characteristics. We also provide the processing data that will enable the ramjet engine manufacturer to produce the solid fuel grain. Helicon's place in the supply chain is the materials supplier for the fuel. Depending on who will fabricate the ramjet engine, our customer could be the Navy directly, or a 2nd-tier contractor, such as Aerojet Rocketdyne or Northrop Grumman Innovation Systems. The prime contractor will likely be either Lockheed Martin or Raytheon, who manufacture the target weapons platforms.

Company Objectives:
Helicon is situated to be a supplier of advanced materials solutions to defense and commercial industries. Beginning with energetic materials (fuels and propellants) for weapons systems, Helicon will continue to develop new technologies in partnership with the government and prime contractors. Dual use applications for SBIR funded technology will continue to be identified, and commercialization efforts for multiple product lines will be pursued using a combination of internal and external funding.

Potential Commercial Applications:
In addition to the energetic materials markets, Helicon is actively pursuing technology applications in sounding rockets and other suborbital/orbital systems including hybrid rocket motors and conventional booster rockets for space launch vehicles. Outside of the fuel/energetics market, Helicon is engaged in research to apply our technology to produce nanocomposite materials for anti-corrosion and self-cleaning coatings, optical materials, phase change heat management systems, and high-performance dielectric materials.

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