# Fuels and Space Propellants for Reusable Launch Vehicles: A Small Business Innovation Research Topic and Its Commercial Vision

*Gelled propellant engine test: 55-wt % RP-1/Al.*

Under its Small Business Innovation Research (SBIR) program (and with NASA Headquarters support), the NASA Lewis Research Center has initiated a topic entitled "Fuels and Space Propellants for Reusable Launch Vehicles." The aim of this project would be to assist in demonstrating and then commercializing new rocket propellants that are safer and more environmentally sound and that make space operations easier. Soon it will be possible to commercialize many new propellants and their related component technologies because of the large investments being made throughout the Government in rocket propellants and the technologies for using them. This article discusses the commercial vision for these fuels and propellants, the potential for these propellants to reduce space access costs, the options for commercial development, and the benefits to nonaerospace industries.

This SBIR topic is designed to foster the development of propellants that provide improved safety, less environmental impact, higher density, higher $I_{sp}$, and simpler vehicle operations. In the development of aeronautics and space technology, there have been limits to vehicle performance imposed by traditionally used propellants and fuels. Increases in performance are possible with either increased propellant specific impulse, increased density, or both. Flight system safety will also be increased by the use of denser, more viscous propellants and fuels.

Many challenges have been overcome recently by the discovery and synthesis of propellants that can have higher performance than traditional $O_2/H_2$, $O_2$/RP-1, and aircraft fuels. This SBIR topic provides a substantial infusion of resources so that these fuels and

propellants can be commercialized for aeronautics and space applications.

Space flight applications of higher performance propellants include high-density monopropellants for sounding rockets and upper stages, and onboard propulsion for small spacecraft. Higher energy fuels, such as $N_4$, $N_6$, $BH_4$, and others, have a longer range development time and would be more applicable to future launch vehicles, such as next-generation Reusable Launch Vehicles. Aeronautical uses are directed toward improving the storage density over typical JP-type fuels and related research in endothermic fuels.

The commercialization of these propellants and fuels will be the major products of this SBIR topic. The development, commercialization, and marketing of these propellants will capitalize on the large investments made in the USAF High Energy Density Materials (HEDM) program, and in other extensive programs in the U.S. Navy, the U.S. Army, the Department of Energy, and NASA.

Our hope is that existing ideas for propellants can be used, and therefore, the development time will be shorter than for typical propellants. Many of the stumbling blocks have been identified and can be avoided with the data from previous testing and research. Many nonaerospace applications also exist; see the following list:

**Applications**

- Particle formation
- Paint additives
- Reflective coatings
- Racing fuel additives
- Cryogenic liquid and solid storage systems
- Cryogenic coolers
- Combined solid-liquid-gas flow systems

**Benefits**

- Higher fuel performance
- Greater fuel safety
- Longer lived coatings
- Higher temperature coatings (for engines, etc.)
- Improved vibration isolation
- Longer cryogenic storage

# Bibliography

Naumann, W.: Small Launchers in the Future: A Global Overview of Their Features and Prospects. Acta Astronaut., vol. 37, Pergamon Press, 1995, pp. 471-486.

Griffin, M.D.; and Claybaugh, W.R.: The Cost of Access to Space. J. Brit. Interplanet. Soc., vol. 47, no. 3, Mar. 1994. pp. 119-122.

Carrick, P.; and Tam, S.: Proceedings of the High Energy Density Matter (HEDM) Contractors' Conference. USAF Phillips Laboratory Report Number PL-TR-95-3039, 1996.

Palaszewski, B.: Atomic Hydrogen Propellants-Historical Perspectives and Future Possibilities. AIAA Paper 93-0244, 1993.

Fleeter, R.; McLoughlin, F.; and Wanagas, J.: Earth-to-Orbit Transportation Optimized for Small Low-Cost Satellites. AAS 91-646, 1992, pp. 377-392.

Palaszewski, B.: Fuels and Space Propellants for Reusable Launch Vehicles: A Small Business Innovation Research Focused Topic. Overview and Technical Briefing Packages, 1996. Available WWW: http://www.grc.nasa.gov/WWW/TU/launch/foctopsb.htm

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