New technologies could solve rocket challenges 800 years in the making

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It may be hard to believe, but solid propellants have been used in rockets since at least the 13th century, beginning with the Chinese. Now, Purdue University researchers are exploring several patented techniques to

address two significant challenges with modern solid propellants – controlling the burn rate and improving overall performance.

The earliest rockets, and some model rockets today, used gunpowder. Solid propellants can be stored easily for long periods and then launched on short notice. They are used for many military applications and used as strap-on boosters to increase payload capacity for a wide range of launch applications.

Purdue researchers have devised three patented technologies to help control the burn rates and also improve performance for modern solid propellants. They are looking at encapsulated catalysts, tailored metallic fuels and embedded reactive burning rate accelerators, or reactive wires, to help address those two critical challenges.

"We have developed creative solutions that could drastically improve performance and to better control the burning rate of solid propellants," said Steven Son, the Alfred J. McAllister Professor of Mechanical Engineering in Purdue's College of Engineering. "Tailoring a burning rate to a specific rocket design is important because it ensures the overall effectiveness of the rocket."

The first Purdue solution is to encapsulate nanoscale catalysts into oxidizers. Catalysts are added to solid propellants to control the burning rate, and by encapsulating them their overall effectiveness is improved and less catalyst is needed, which will result in higher performance.

Purdue's second technology involves engineering metal powders, such as aluminum, which are used as a fuel in many solid propellants. The team fabricated mechanically activated metallic fuels, resulting in micrometer-scale aluminum particles with intraparticle nanoscale structures of a second material, which improves the ignition and combustion of the metal powders that increase burning rates and could also decrease so-

called two-phase flow losses to overall performance.

The third solution created at Purdue focuses on embedded reactive material burning rate accelerators. Solid rocket propellants burn from the surface of an exposed propellant in the combustion chamber outward. The Purdue solution, embedded mechanically activated reactive foils in propellants, has been shown to significantly increase the effective burning rate of propellants as the embedded foils open new surface area for combustion. This could enable a more propellant in the rocket motor initially, leading to increased range and significantly improved performance.

Provided by Purdue University