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Thermally-Expandable Microspheres in Explosives and Propellants for Tunable Detonation and Deflagration Control

A safer energetic formulation that stays inert until remotely heat-activated, improving storage, handling, and tunable detonation control.

Researchers at Purdue University have developed a method that incorporates thermally expendable microspheres (TEMs) in explosives and propellants to formulate switchable energetic materials. Improving the safety of explosives has long been a predominant initiative. Fluid-activated switchable and insensitive explosives, such as TATB and ammonium nitrate, are commonly used to mitigate safety issues. However, these options are not completely impervious to accidental explosions despite their ability to reduce the risk of storing, transporting, and handling explosive materials.

The method developed by Purdue researchers helps manufacturers of solid explosives, propellants, and fuels significantly increase the safety of transportation and storage of explosives. Switchable explosives are not detonable until activated unlike their insensitive counterparts, which are always detonable and have low sensitivity compared to other explosives. The switchable explosives can be rendered functional or inert ad hoc by remote activation through heating, providing a safer alternative than current methods.

Technology Validation:

The researchers conducted an X-ray micro-computed tomography to quantify the microstructural changes and expansion of the TEMs for unheated and heated samples. Results showed an increase in sample size and porosity for the heated sample due to the expansion of the TEMs. Detonation experiments verified the switched performance. This finding demonstrates TEMs' ability to be mixed into rubberized explosive formulations and increase the porosity/hot spot locations within the explosive.

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Category
Aerospace & Defense/Defense Electronics & Surveillance Technologies
Aerospace & Defense/Hypersonics & Propulsion Systems
Chemicals & Advanced Materials/Materials Processing & Manufacturing Technologies

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Advantages:

-Enhances tunable performance and deflagration control of explosive materials

-Improves transportation and safety of storing and handling explosives

-Improves safety via remote activation for detonation

Applications:

-Department of Defense

-Department of Energy

-NASA

-Mining Companies

TRL: 4

Intellectual Property:

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Keywords: Auto cascade heat pumps, Heat Pumped Distillations, Heat pumps for Chemical Plants, Heat pumps for manufacturing applications, High temperature lift heat pumps, Mixed Fluid heat pumps