

Improved Insensitive Munitions with Higher Performance

A new class of binders for explosives and propellants that offer greater energy density in a more stable package.



Explosive binders are used in munitions to shape the explosive material and to improve safety. Binder material is a necessary additive, however, it negatively impacts energetic performance. This new innovation using polyphosphazenes improves energetic performance and improves stability.

Polyphosphazenes (PPZ) are a class of flexible polymers that have been proposed for a wide variety of uses from dental and medical applications to PCBs, and 3D printing. The technology still requires some maturation, however, PPZs offer benefits and disruptive potential to a wide range of applications.

Conventional polymeric binders are used to enhance safety and improve the mechanical properties of explosive material such as Polymer Bonded Explosive (PBX). However, the addition of these polymeric binders reduces the energetic performance of the original material.

Polyphosphazenes for explosive binders

Although classified as non-explosive, a baseline PPZ has class-leading energy content. Polyphosphazene-based binders offer numerous improvements such as higher energy density and improved safety.

A demonstrator energetic PPZ has shown to have a high energy density, can be cured, and is transportable as a flammable solid.

Benefits

- » **High Performance** - PPZ used as a replacement explosive binder improves energetic performance.
- » **Reduced Hazard** - PPZs inherent stability greatly enhances safety in the handling of the material which can be transported as a flammable solid.
- » **Easily Shaped** - can be readily shaped by pressing or curing and demonstrates good explosive adhesion.

Applications

The synthetic flexibility of PPZs allows them to be fine tuned to a wide range of explosive applications.

- » Rocket or gun propellants
- » Explosives (especially PBX formulations)
- » Pyrotechnics, decoys and flares

AWE Polyphosphazene

The development of the AWE PPZ range of binders was driven by a requirement to create a material with high energy density and life, as well as elastomeric properties with low glass transition temperatures.

Shaping

The AWE PPZ can be readily shaped by pressing or curing. Samples have been produced using free-flowing moulding powders pressed at 2 tonnes for 5 minutes.



Above: An example of the AWE PPZ used as a binder with FOX-7 high explosive (HE) compound. The inset microscopy image shows the PPZ achieved good adhesion and covered the crystals evenly.

Testing and performance

Manufacture of the AWE PPZ materials has been successfully achieved from a commercially available, single, stable, low-cost/non-exotic, non-hazardous precursor phosphazene polymer. Several kilogrammes have been produced for explosives use with small scale demonstrations conducted.

Samples have also been provided to the US Naval Air Warfare Centre Weapons Division for testing as an environmentally friendly rocket motor propellant. Their report, conducted under SERDP SEED Project WP-2141, is publicly available.

Intellectual Property

The technology is protected by three families of granted patents.

- » US 2008/0108784 & JP 2013/049619A
- » US 2015/0141540
- » US 2015/0144017

More information

For more information about licensing this technology, or to speak to us about our other materials science related IP, please contact us.

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