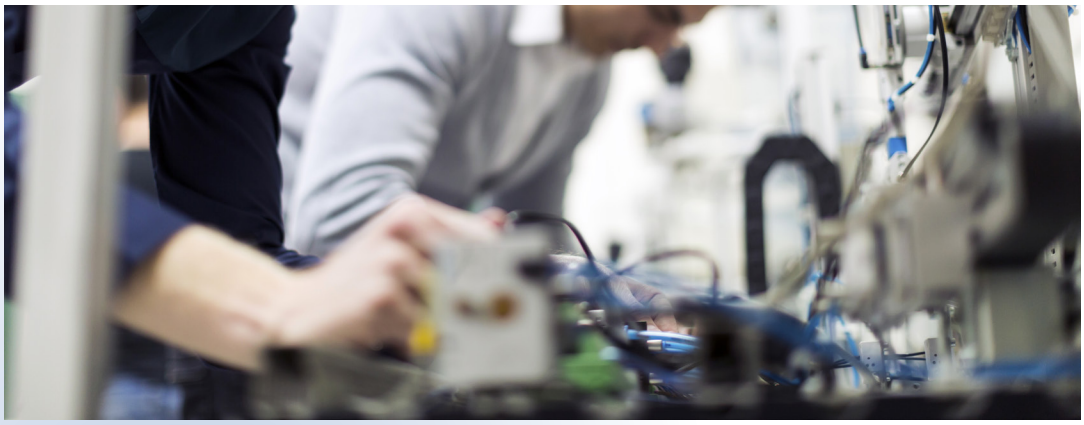

Safe and effective energetic materials and initiators

Energetic materials designed to explode and/or burn on demand are widely used for military, industrial and police purposes. However, many of these materials and the devices used to ignite them are relatively unstable and prone to unintended ignition by low-energy sources such as static electricity (electrostatic discharge), fire, friction or shock. Their use entails considerable risk, not only to primary users, but also to transporters and the public.

Researchers at Idaho National Laboratory are developing energetic materials that are capable of delivering powerful explosive energy, yet demonstrate unprecedented improvements for safer storage, handling, transportation and operation. INL investigators are also working to increase the safety of ignition devices to ensure energetics detonate only when required.

Safer Energetic Materials

Powdered composite energetic materials (containing a metal (fuel) plus an oxide (oxidizer)) are effective for a wide variety of applications, but their potential for unintended detonation due to electrostatic discharge or exposure to unintentional fire, as well as their unstable form, make their use challenging and dangerous.

Electrostatic Discharge Resistance:
Scientists at INL, working with colleagues at Texas Tech University, have developed a patent-pending method of producing and handling these materials that substantially reduces their sensitivity to electrostatic discharge by adding carbon nanotubes to the mixture, reducing conductivity by almost 10 orders of magnitude without affecting ignition by intentional means. Experiments show that when voltage is applied to materials containing nanofillers, the materials will not ignite. Current travels through the nanofillers, bypassing the energetic material and preventing it from heating and igniting. The energetic material remains fully responsive to normal ignition methods.

Fire-proof Pyrotechnics:
Composite energetic materials are highly susceptible to unintended detonation – ignition of pyrotechnics by accidental fire has resulted in several catastrophic events resulting in significant loss of life and property. INL researchers have developed a technique for making composite energetic materials inherently resistant to accidental ignition by fire by including an additive that breaks down at lower heating rates associated with fire. After the material has been exposed to fire, it can no longer be detonated by higher

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The Energy of Innovation

Idaho National Laboratory

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ignition rates. If the material is not exposed to accidental fire, it performs as designed when intentionally detonated.

Flexible Energetics:
Combining composite energetic materials with a silicone binder, researchers developed a material that can be extruded, molded and blade cast into flexible sheets. The consolidated material is flexible, waterproof, free-standing, and easy-to-handle, providing consistent, localized energy when intentionally ignited, and is inert to electrostatic discharge.

Technological benefits:

- The risk of ignition by electrostatic discharge is greatly reduced
- The risk of ignition by exposure to accidental fire is greatly reduced
- Flexible material can be used in many applications where standard composite energetic materials would fail.

Safer Ignition

Energetic materials may be detonated by a variety of ignition methods, each presenting its own unique hazards. INL scientists have designed several patent-pending methods and devices to improve safety surrounding ignition of energetic materials.

Hybrid Exploding Bridge Wire:
Researchers in INL's materials group have developed a patent-pending low-pressure initiator for safer ignition of non-high explosive energetic materials such as pyrotechnics – the Hybrid Exploding Bridge Wire (HEBW). Retaining the same safety features as exploding bridge wire initiators, the HEBW avoids the dangers of accidental ignition by electrostatic discharge by incorporating a spark gap in addition to the bridge wire, ensuring initiation only occurs when a threshold voltage is applied. In addition, the HEBW produces a much smaller pressure wave, improving compatibility with powdered energetics.

Tactical Timed Firing Device:
INL's Electrical Design Group has designed an initiation device with a removable key that includes an LCD display synchronized to the LED countdown display on the device, enabling the user to take the countdown time with them, allowing safer monitoring and management of the detonation event. Data verification is shared between the main unit and removable key to prevent unauthorized ignition.

Technological Benefits:

- HEBW provides resistance to electrostatic discharge, much smaller pressure wave that is compatible with energetics in loose powder form
- TTFD – countdown timer on key provides extra margin of safety, unit/key verification prevents use by unauthorized persons

Applications:

Military, police, mining, infrastructure, quarrying, oil and gas exploration

For more information

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