Making a safer bang for the buck

Four ground-breaking families of environmentally friendly primary explosives under development at Los Alamos National Laboratory are featured this week in the *Proceedings of the National Academy of Sciences*.

"The environmental contamination and the health risk to personnel caused by mercury and lead in primary explosives has been a problem for nearly 400 years, but our team's recent research identifies replacements that are stable, appropriately sensitive, and suitably explosive," said scientist My Hang Huynh, the lead researcher.

Huynh's research focuses on replacing current lead-based primary explosives with nitrotetrazole chemical complexes and by altering the distribution of charge on the molecule.

The new chemical compounds provide variations in the sensitivity and performance of the explosives, designed for use in industrial detonators, U.S. Department of Defense munitions, and hunting ammunition.

"Our inorganic primaries, including the four new families, can be manufactured to be insensitive to light and moisture, sensitive to initiation but not too sensitive to handle and transport. They are thermally stable at more than 480˚F, chemically stable for extended periods, devoid of toxic metals such as lead, mercury, silver, barium, or antimony, and free of perchlorate," she said.

"The new compounds are easier to prepare, safer to handle, and more convenient to transport because they are completely inert when wet. More important, they release to the environment only nontoxic metal and harmless gaseous byproducts upon detonation."

Nitrotetrazole previously had only been effective as an explosive when coupled with perchlorate, another toxic chemical compound.

An initial paper presented in March in the proceedings described the nitrotetrazolato-N2-ferrate concept. A new paper expands findings to include four novel types of environmentally friendly primary explosives:

* cat[FeII(NT)3(H2O)3],

* cat2[FeII(NT)4(H2O)2],

* cat3[FeII(NT)5(H2O)], and

* cat4[FeII(NT)6]

(cat = cation, a positively charged ion, and NT- = 5-nitrotetrazolato-N2).

Huynh, an inorganic chemist, collaborated with colleague Michael Hiskey and began exploring different compounds created with 5-nitrotetrazolato-N2 (NT) and combinations of metal ions such as iron and copper. These primaries can initiate large explosions and leave behind only water, nitrogen, and harmless waste byproducts.

With available alkaline, alkaline earth, and organic positively charged ions as partners, four series of 5-nitrotetrazolato-N2-ferrate hierarchies provide a plethora of green primaries with varied initiating sensitivity and explosive performance.

Traditional explosive primaries have relied on two lead-based compounds, lead styphnate and lead azide, both of which leave toxic fumes and debris. A 1991 study showed that employees at an FBI shooting range had lead contamination levels 10 times higher than U.S. government limits.

Before the lead products were devised, mercury fulminate was the main primary explosive, and the lead replacements were identified as the only viable primary explosives. Huynh's goal has been to replace these poisons with materials that will provide the required explosive energy without environmental and personnel health problems.

Reference: My Hang V. Huynh, Michael D. Coburn, Thomas J. Meyer, and Modi Wetzler. Green primary explosives: 5-Nitrotetrazolato-N2-ferrate hierarchies PNAS published June 27, 2006, 10.1073/pnas.0604241103 (Environmental Sciences-Biological Science).

Source: Los Alamos National Laboratory