Safer substitute for lead azide

July 2 2014

This shows the result of a test in which 500 mg of the new explosive material was detonated under controlled conditions in the laboratory. Credit: Thomas M. Klapötke

Lead azide, which is toxic, is a basic component of munitions and detonators. LMU chemists have now synthesized a novel primary explosive that contains no lead.

Primary explosives require careful handling, not only because of the ease with which they can be detonated, but also because the metal common to the two compounds most often employed for this purpose – lead azide and lead styphnate – is toxic and carcinogenic. Long-term use of these materials thus results in significant levels of environmental contamination. A research group at LMU's Department of Chemistry, led by Professor Thomas M. Klapötke, has therefore developed a novel

primary explosive which is free of heavy metals. The new material is described in a paper that appears in the journal *Angewandte Chemie*.

"The sole metal present in K2DNABT, our new explosive, is potassium, an element that is both ecologically and toxicologically innocuous. With respect to its sensitivity to shock, friction and static electricity, the new material is at least as stable as lead azide, as our laboratory experiments have shown," says Klapötke.

Noxious dust

Primary explosive materials are used to initiate the detonation of less sensitive secondary explosives. The former can be ignited by applying a mechanical shock, which rapidly generates a propagating shock wave that is sufficiently powerful to detonate the secondary explosive. As a result, the lead azide is converted into elemental lead and released in the form of fine particulates. "Each detonation releases a few milligrams of finely divided lead, but the toxic effect depends on the overall concentration. The deleterious effects on the environment are most obvious in military training grounds, where lead release has occurred regularly for decades and the metal has accumulated to critical levels." Soldiers and civilian personnel who are responsible for the care and use of weapon systems are also regularly exposed to its toxic effects. "Studies carried out by the US Army demonstrate that particularly those who are employed in clean-up operations in these areas have higher levels of lead in the blood than do military personnel who have had no contact with explosives."

Lead azide-based explosive materials are used in both military and non-military contexts. "The ammunition currently used by police forces, and the detonators used in mining and other industries generally contain lead azide," says Klapötke. "According to the US Army, some 10 million lead azide-containing devices, everything from cartridges to detonators, are

produced in the US every year, and the military sector alone consumes around 750 pounds of the compound annually.

Initial experimental detonation tests of K2DNABT carried out in the laboratory, as well as theoretical calculations, have shown that, in terms of its chemical properties, the new material offers several advantages over lead azide. "We have reason to believe that it has high long-term stability, and can be stored for many years. That would be a significant advantage relative to DBX-1, a copper-containing agent previously developed as an alternative for lead azide which, however, can decompose over time," says Klapötke. The researchers' next task is to synthesize larger quantities of the new compound, which will then be tested outside the confines of the chemistry lab.

Provided by Ludwig Maximilian University of Munich