

Chemists use high speed camera to fully explain high school explosion demonstration

January 27 2015, by Bob Yirka



First experiments of the alkali metal explosion in water performed at the balcony of the Institute in Prague provided important clues for later more rigorous laboratory studies (and lots of fun). Credit: Phil Mason

(Phys.org)—A team of researchers with members from Czech Republic and Germany has found that the general explanation given to high school chemistry students regarding the reasons for an explosion when alkali metals are dropped into water, is insufficient. In their paper published in the journal *Nature Chemistry*, the group explains how they filmed such reactions and discovered what really happens.

Most chemistry students have seen it—an instructor drops a bit of alkali metal into a beaker of water and a flashy [explosion](#) occurs—up till now, the explanation has been that as electrons leave the metal, hydrogen is formed which then ignites. The researchers in this new study do not dispute that claim, but have found that there is more to it.

The researchers note that the traditional explanation for the cause of the explosion has not really been fully explained, after all they note, there is little [surface area](#) for the reaction to occur and as the hydrogen forms, it would appear to form a barrier between the two materials, further squelching the possibility of an explosion. To find out what really goes on, they filmed drops of a sodium-potassium alloy as they hit the surface of a container of water. Slowing down the reaction revealed that just microseconds after the drops hit, tiny spikes of metal protruded from the impact zone. That, the researchers noted caused more surface area between the two materials coming into contact, and also allowed for piercing the layer that formed between them, allowing the explosion to proceed.

High school teachers, the team notes, correctly tell their students that electrons leave the metal and enter the water, but generally neglect to mention that the metals then become highly positively charged. It is that charge that is responsible, they suggest, for the formation of the spikes, which are the real reason for the explosion. The team created a computer simulation of what they observed and found the same results, verifying that they had found the real process involved in such explosions.

The team allows that there is likely little real world application for what they have discovered, but hope that in the future, [high school teachers](#) will be able to give the full story as they attempt to wow future chemists.

More information: Coulomb explosion during the early stages of the

reaction of alkali metals with water, *Nature Chemistry* (2015) [DOI: 10.1038/nchem.2161](https://doi.org/10.1038/nchem.2161)

Abstract

Alkali metals can react explosively with water and it is textbook knowledge that this vigorous behaviour results from heat release, steam formation and ignition of the hydrogen gas that is produced. Here we suggest that the initial process enabling the alkali metal explosion in water is, however, of a completely different nature. High-speed camera imaging of liquid drops of a sodium/potassium alloy in water reveals submillisecond formation of metal spikes that protrude from the surface of the drop. Molecular dynamics simulations demonstrate that on immersion in water there is an almost immediate release of electrons from the metal surface. The system thus quickly reaches the Rayleigh instability limit, which leads to a 'coulomb explosion' of the alkali metal drop. Consequently, a new metal surface in contact with water is formed, which explains why the reaction does not become self-quenched by its products, but can rather lead to explosive behaviour.

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