Chemists develop new formulation for the generation of green flames

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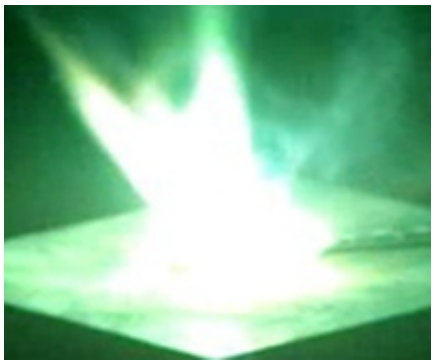

LMU chemists have developed a new formulation for the generation of green flames. Unlike conventional mixtures, the new blend of reactants is environmentally benign, and it produces a green flame of previously unattained purity.

The reaction mixture normally used in green signal flares contains two toxic chemicals: barium nitrate – which emits green light when combined with a chlorine donor – and potassium perchlorate, which serves as an oxidizing agent. A team of chemists led by Professor Thomas M. Klapötke, Chair of Inorganic Chemistry and High-Energy Materials at LMU Munich, has now come up with a non-toxic alternative formulation, which also gives rise to green light of higher spectral purity. The work has just been published in the journal *Chemical Communications*.

"It has long been thought that emission of a green flame requires the use of metal-based oxidizers," says Professor Klapötke. But the barium employed in current signal-flare formulations is a suspected cardiotoxin, and the chlorine donors which combine with the barium salt to produce the green emitter are also highly toxic, producing carcinogens upon combustion. The health risks posed by the conventional reaction mixture have therefore prompted the search for safer alternatives. Three years ago, American scientists proposed the use of a combination consisting of boron carbide and potassium nitrate as a replacement. However, the results obtained with these reactants were unsatisfactory. "The spectral purity was relatively low, so the green looked rather pale and bleached," says Klapötke.

In collaboration with Dr. Jesse Sabatini of the US Army's Pyrotechnics Division (ARDEC), the LMU chemists have now devised an improved and non-toxic combination of reactants for the purpose. It also is based on boron carbide as the green emitter, but uses trinitroethylborate (TNEB), an oxidizing agent developed in Klapötke's laboratory at LMU several years ago instead of potassium nitrate. The green flame generated by the new mixture has a spectral purity of 85%, significantly higher than the figure of 65% achieved by the best available traditional flares. "This is one of the greenest greens ever produced by pyrotechnical means," says Magdalena Rusan, a member of the LMU team.

"Its extremely low sensitivity to shock and friction represents a further advantage of the new formulation," says Thomas Klapötke. The next step is the measurement of its susceptibility to humidity. As it stands, however, the new blend scores highly on two scales of "greenness".

More information: "Improved green-light-emitting pyrotechnic formulations based on tris(2,2,2-trinitroethyl)borate and boron carbide." Thomas M. Klapötke, et al. Chem. Commun., 2014,50, 9581-9583. DOI: 10.1039/C4CC04616A

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