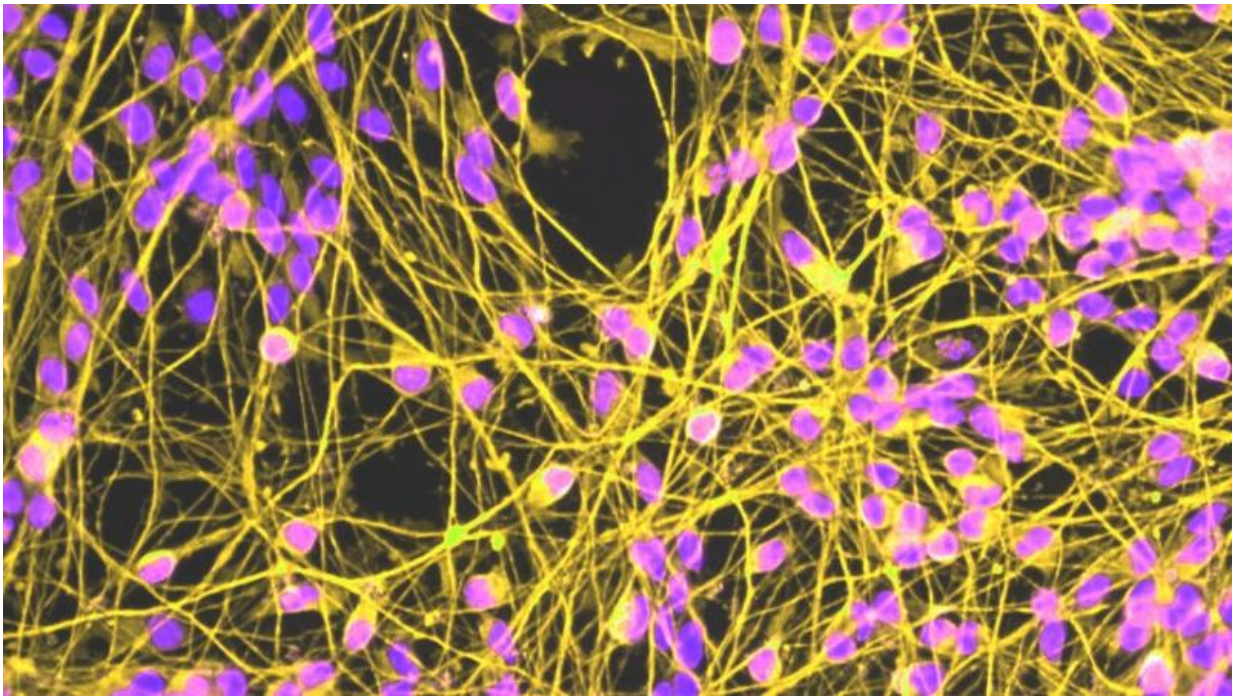
Researchers develop new flame retardants

July 18 2016, by Cornelia Zogg



Credit: Swiss Federal Laboratories for Materials Science and Technology

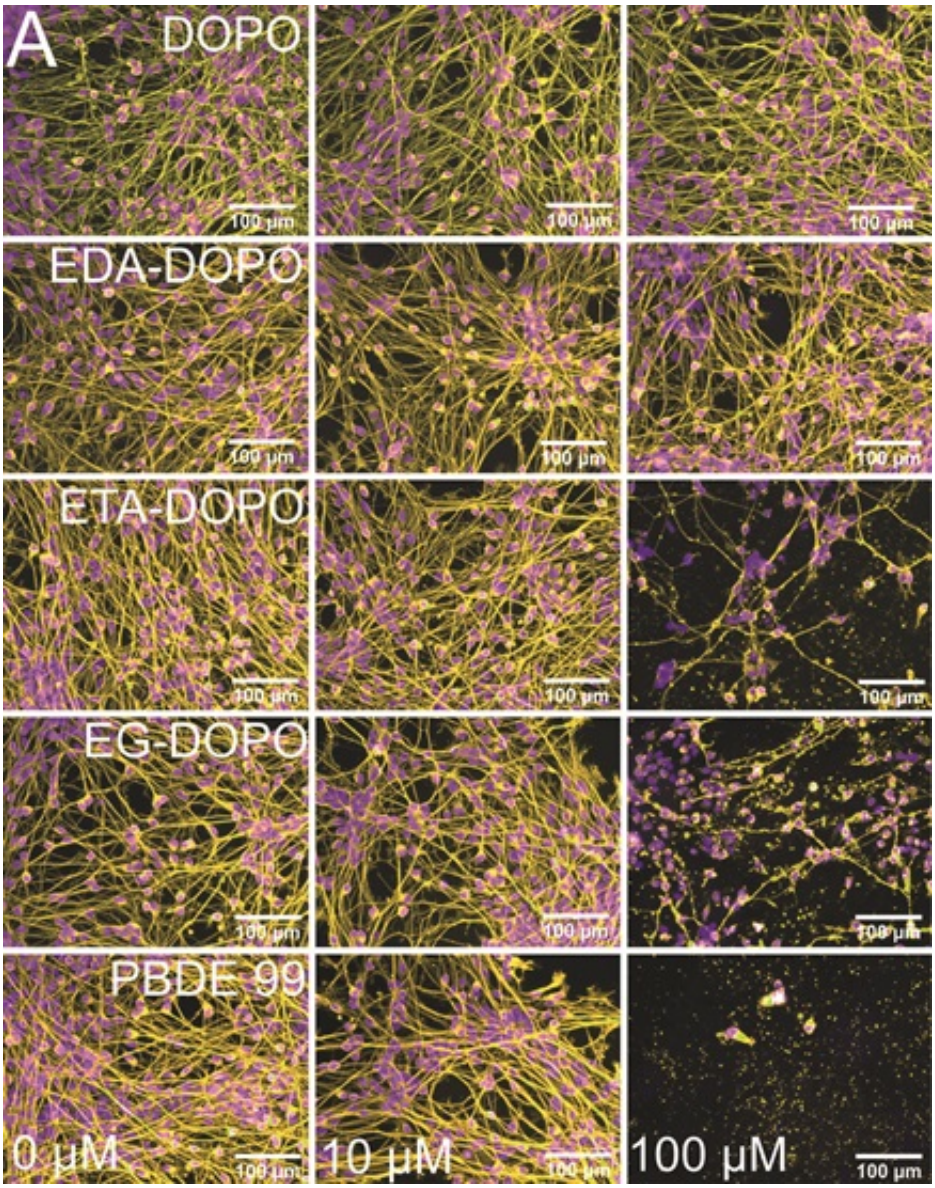
Flame retardants are invisible assistants in car seats, gasket sealants, furniture and even in aeroplanes. However, their ingredients are not always harmless. Empa researchers developed three innovative flame retardants and tested them for toxicity; not all of them passed the test.

Researchers are constantly striving to develop better and safer flame retardants. For example, Sabyasachi Gaan's team at Empa's Advanced

Fibers Laboratory, synthesised three new agents that have the same or improved flame retardancy as existing products. However, before a flame retardant is ready for mass production, it is essential to ensure its safety for humans. The fact that a toxicological evaluation is beneficial prior to use is highlighted by the example of the flame retardant TCCP, which was only classified as toxic to humans after its launch and must now be gradually removed from the market. The newly developed flame retardants from Gaan and his team are derivatives of an existing agent (DOPO) and are called ETA-DOPO, EG-DOPO and EDA-DOPO. Experts at Empa's Particles-Biology Interactions Laboratory subjected the substances to a toxicological cross-check.

Toxicological tests with different cell types

The team, led by Cordula Hirsch, exposed both lung cells and macrophages (scavenger cells) to a number of flame retardants. The Empa researchers could only conclude that there were no toxic reactions for one of the three substances. However, the lungs are primarily affected by flame retardants during production and processing in powder form. Subsequently, the toxic substances enter the body by penetrating the skin and there can give rise to skin damage or even neurotoxic effects.



in vitro culture of human nerve cells (yellow; nuclei: purple) exposed to various concentrations of different flame retardants: PBDE 99 is already in use and suspected to be harmful to health; the substance was thus used as a positive control. At a concentration of 100 µM, PBDE 99 as well as ETA-DOPO and EG-DOPO showed significant damage to the cells. In contrast, this was not observed for DOPO and EDA-DOPO. Credit: Swiss Federal Laboratories for Materials Science and Technology

Hirsch, therefore, passed the samples on to Stephanie Mathes at the Zurich University of Applied Sciences (ZHAW) in Wädenswil, who examined the new flame retardants for skin tolerance with her team. Here, the researchers cultivated human skin and exposed it to varying concentrations of the flame retardant. Stefan Schildknecht and his colleagues at the University of Konstanz were responsible for the neurological investigations. He examined the direct impact of the substance on neural effects using tests involving brain cells.

The conclusion of the researchers: two of the three flame retardants failed the tests. Both of these resulted in damage to the test cells used and will thus not be developed further. However, the researchers also showed that the newly developed EDA-DOPO not only has better flame retardancy than previously available products, but also had no toxic effects at all in the tests that were conducted. EDA-DOPO is thus a good candidate to take forward to a next stage of development.

More information: Cordula Hirsch et al. Multiparameter toxicity assessment of novel DOPO-derived organophosphorus flame retardants, *Archives of Toxicology* (2016). DOI: 10.1007/s00204-016-1680-4

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