Researchers create 'bio inspired' flame retardants

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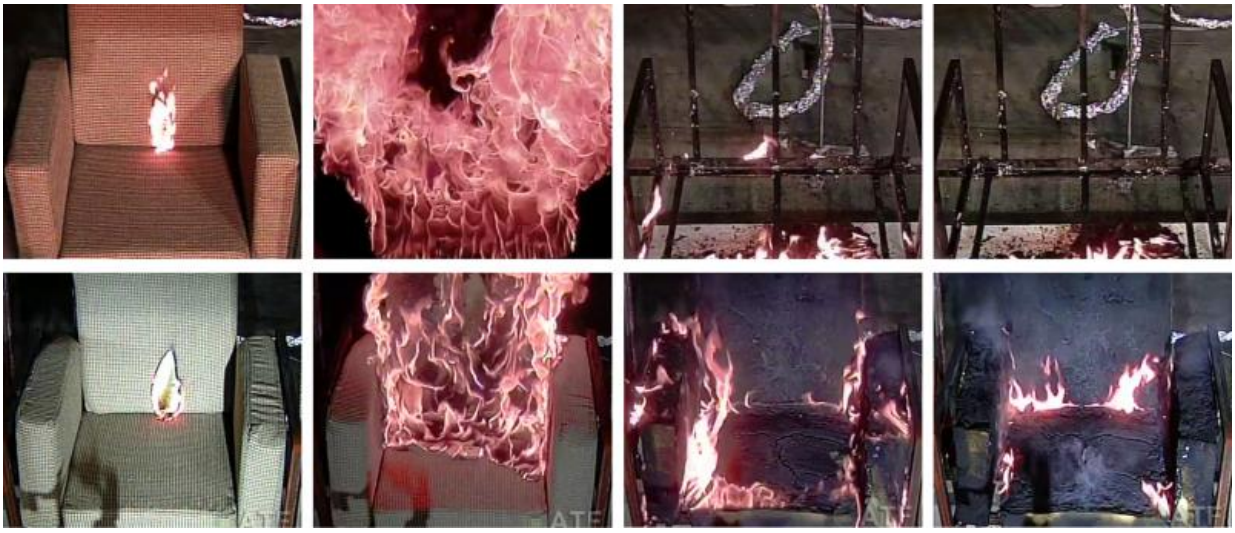

Fire tests demonstrate the flame-retarding benefits of a new "bio-inspired" coatings developed by NIST researchers. One chair (top) is padded with untreated foam; padding in the other chair is coated with the experimental flame retardant. After ignition (0:24), the upholstery fabric on both chairs is consumed in flames (2:30). Six minutes after ignition, the untreated cushion burned completely, leaving a melt pool that continues to burn. Flames on the treated padding release less heat and remain confined to the cushion. Unable to sustain combustion, flames on the treated cushion are nearly extinguished after nine minutes. Credit: NIST

After devising several new and promising "green" flame retardants for furniture padding, National Institute of Standards and Technology

(NIST) researchers took a trip to the grocery store and cooked up their best fire-resistant coatings yet. As important, these protective coatings can be made in one straightforward step.

As reported in a new article, the NIST team prepared nine water-based mixtures made up of various combinations of potato starch, seaweed gel (agar), laundry booster, clay and similar everyday compounds. In laboratory tests, six of these "bioinspired" coatings reduced the peak heat release rate—a key measure of flammability—of polyurethane foam by at least 63 percent, compared with untreated foam.

Encouraged by the lab results, the team subjected the top-performing mixture—starch and a boron-containing compound used in deodorant and other products—to a full-scale fire test. That entails igniting the seat cushions of entire chairs padded with treated or untreated polyurethane foam.

The untreated chair, upholstered with a synthetic fabric, was completely engulfed in flames 90 seconds after ignition and was completely consumed in less than two minutes.

In contrast, the fire in the chair treated with the NIST-devised coating remained confined to the cushion 90 seconds after ignition, even though the fabric covering had burned completely. The researchers recorded a 71 percent drop in the total amount of heat released, so that combustion could not be sustained and the flames did not spread.

Furniture fires are the leading cause of casualties in house fires. In 2013, they accounted for about 30 percent of more than 2,700 deaths in residential fires, according to the National Fire Protection Association. Fires that start in furniture, such as those lit by a burning cigarette or a nearby heater, account for the largest share, but furniture also serves as a major fuel source for fires that originate elsewhere.

"The results of the full-scale fire tests are very encouraging," says NIST team leader Rick Davis. "The performance of our coating suggests that fire can be contained to burning furniture so that it does not spread, intensify to the point of flashover, and increase the risk of injury or death."

Earlier candidates for "green" flame retardants formulated by the NIST group were made with a "layer by layer" deposition process that required repeating a series of steps to create stacks of coating layers. The newest coatings were crafted with what the researchers call a "one-pot" process: add ingredients to water, heat, stir until the solution turns to a gel, and then cool. Depending on the ingredients, preparation times ranged from about 30 minutes to two hours.

To achieve uniform coverage, foam is immersed in the solution for two minutes.

The uncomplicated process could lend itself to industry adoption. However, additional research is necessary to determine the durability of the new coatings and to assess other properties affecting performance and manufacturing applications.

In addition to furniture, chemical flame retardants are used in a variety of other consumer products. Several have been banned, and some others have been linked to human health risks and environmental problems. NIST's bio-inspired, experimental coatings are contributing to the search for alternatives.

More information: "One-Pot, Bioinspired Coatings To Reduce the Flammability of Flexible Polyurethane Foams" ACS *Appl. Mater. Interfaces*, 2015, 7 (11), pp 6082–6092 DOI: 10.1021/acsami.5b01105