All-natural mixture yields promising fire retardant

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(Phys.org) —What sounds like fixings for a wizard's potion—a dash of clay, a dab of fiber from crab shells, and a dollop of DNA—actually are the ingredients of promising green fire retardants invented by researchers at the National Institute of Standards and Technology (NIST).

Applied to polyurethane foam, the bio-based coatings greatly reduced the flammability of the common furniture padding after it was exposed to an open flame. Peak and average rates of heat release—two key indicators of the magnitude of a fire hazard—were reduced by 48 percent and 77 percent, respectively, the NIST team reports in the journal *Green Materials*.

"This is the biggest reduction in flammability that we have achieved to date," says team leader Rick Davis. The all-natural coatings outperform other promising experimental fire-retardants that the NIST researchers have devised with their layer-by-layer assembly method.** But Davis says the bio-based coatings must be applied more generously, in stacks of about 20 layers as compared with six or seven layers.

Although still under study, the all-natural formulations might offer an alternative to existing fire retardants, including some that have been linked to human health risks and environmental problems.

The new coatings use negatively charged DNA molecules to link two positively charged materials known to enhance fire resistance:

montmorillonite, a type of soft clay that forms tiny crystals, and chitosan, a fiber derived from the shells of shrimp, lobsters and other crustaceans. For its part, DNA, which was obtained from herring sperm, may also confer added protection because it bubbles and swells when heated, protecting the material beneath.

The team tested four different combinations of the three ingredients. In each combination, clay, chitosan and DNA were ordered in a specific arrangement and then stacked 20 to 30 layers high. Of the four, the best candidate for a bio-based fire retardant, according to the researchers, appears to be 10 repeating bilayers of chitosan overlain by a mixture of DNA and montmorillonite.

Besides providing the highest level of fire protection, the bilayer arrangement "is likely to be easier, faster, and less expensive to fabricate" than the other combinations, the team reports. However, this coating increased the weight of the foam by 16 percent. A lighter alternative, which provides only slightly less fire protection, is a coating that features five repeating four-layer stacks, each consisting of chitosan, DNA, chitosan, and clay. This arrangement increases the foam's weight by 5 percent.

"Both recipes are great candidates" for environmentally benign fire -retardant coatings, the team says.

Ongoing research aims to simplify processing, enhance effectiveness, and test strategies to ensure durability.

More information: Y-C Li, Y-H Yang, Y.S. Kim, J. Shields and R.D. Davis, DNA-based nanocomposite biocoatings for fire-retarding polyurethane foam. *Green Materials.* Available on line at: www.icevirtuallibrary.com/content/issue/gmat/2/2

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