# Making wooden construction materials fire-resistant with an eco-friendly coating

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Coated wood (left) can resist flames, limiting fire damage, unlike bare wood (right). Credit: Ethan Iverson

Devastating residential blazes and wildfires take a terrible toll in terms

of deaths and injuries, as well as property loss. Today, researchers will report on a new type of coating that could limit the flammability of wood used in construction, potentially providing more time to escape fires and also curbing their spread. The environmentally friendly flame retardant could also be used for other flammable materials, such as textiles, polyurethane foam and 3-D-printed parts.

The researchers will present their results today at the spring meeting of the American Chemical Society (ACS).

Home fires account for the majority of fire deaths and lead to billions of dollars in property damage every year, according to the National Fire Protection Association. Adding fire sprinklers and smoke detectors can help, but another approach is to make construction materials less flammable. That's the goal of Thomas Kolibaba, Ph.D., who is developing a new coating for these materials. "This type of treatment, which could be deposited via dipping, spraying or pressure treatment, could make homes much safer," he says. "The coating could reduce flame spread and smoke production, which could limit damage and give people more time to evacuate." Unlike most current fire retardant treatments, its ingredients are environmentally benign, and it might also cost less, notes Jaime Grunlan, Ph.D., the project's principal investigator.

Kolibaba carried out the research as a graduate student and postdoc in Grunlan's lab at Texas A&M University, building on polyelectrolyte coating technology invented by the group in 2009 and later extended by other researchers. Most of these coatings are formed by dipping fabric or other items in a solution containing one polymer with lots of positive charges on it, followed by a dip in another solution containing a polymer with lots of negative charges, and then repeating these steps to reach the desired thickness. The opposing charges draw the polyelectrolyte molecules in the alternating layers together into complexes on the item's surface, forming a coating that can extinguish a flame.

Kolibaba wanted to extend this treatment to wood, but the multistep process wasn't feasible for manufacturers because wood takes too long to soak up these chemicals. Through further research he adapted another Grunlan technique, thereby cutting the number of steps down to two: one dip to coat the wood, followed by a dip in a different solution to cure the coating by changing the pH. But that second solution kept turning into a sticky mess, so the streamlined process still wasn't convenient for industrial or consumer applications.

In the latest modification, which will be presented at ACS Spring 2022, Kolibaba overcame that problem with a procedure that he says would be easy for industry or consumers to adopt. He dipped plywood in an aqueous solution containing the positively charged polymer polyethylenimine (PEI), the monomer hydroxyethyl methacrylate phosphate (HMP) and a photoinitiator known as TPO. Instead of dipping the wood in a second solution to cure, he exposed it to ultraviolet (UV) light for a few minutes. That caused TPO to turn the HMP into a negatively charged polymer, which then formed a polyelectrolyte complex with PEI. The resulting coating was transparent and only a few micrometers thick, so it didn't change the wood's appearance and added only slightly to its weight.

In lab flame tests, the treated wood lowered the amount of heat released during burning and quickly formed a surface layer of char that protected the underlying wood—features that could limit fire damage and spread. "It also reduced smoke production by 56%, an unusually large degree," Kolibaba says. Unlike the team's prior coatings, which are held together by ionic bonds, this one is covalently bonded. So Grunlan expects it to be water-resistant—and therefore durable—and possibly also water-repellent and antifungal.

Industrial users could coat construction materials, such as wooden studs and other framing, or oriented strand board (a type of engineered wood

similar to particle board). Homeowners could use a backpack sprayer to protect existing structures such as fences or barns, which have been shown to propagate wildfires, Kolibaba says. Other potential applications include textiles and polyurethane foam for clothing, home furnishings, and the automotive and aviation sectors, Grunlan says. The UV-curable polyelectrolytes could also be used as a resin to make 3-D-printed parts, which are flammable when made with conventional resins, Kolibaba adds. That could be particularly beneficial in aerospace settings, such as the International Space Station, he notes.

**More information:** Polyelectrolyte photopolymer complexes for flame retardant wood, ACS Spring 2022. acs.digitellinc.com/acs/live/22/page/677

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