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STUCK ON STARCH

# A New Wood Adhesive

Environmentally conscious shoppers may soon be able to furnish family rooms and offices with items made from a surplus farm product—starch.

Each year, the plywood paneling and furniture made from particle board and sold in the United States contain more than a billion pounds of adhesives. “Industrial wood adhesives are now made solely from petroleum and natural gas,” says ARS chemist Syed H. Imam, “but we’ve found a way to make them from a combination of other ingredients, including starch.”

Imam works in the Biopolymer Research Unit of the National Center for Agricultural Utilization Research, Peoria, Illinois. He and his colleagues came upon the idea of making wood adhesives from starch while researching totally biodegradable, starch-based films. Their goal is to find ways to make alternatives to plastic agricultural mulch films now used to curb weed growth in high-value agricultural crops.

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**Chemist Syed Imam examines pellets of the sticky extruded material that led to the development of starch adhesive.**

The scientists made biodegradable films from a slurry of starch and dissolved polyvinyl alcohol, which they processed through a machine called an extruder. Noting the hot film was quite sticky while coming out of the extruder, the researchers considered the chemistry. "We reckoned the material could be made into an excellent adhesive to bind layers of veneer," Imam said. "What we needed to do was make the material more flowable so it could be easily brushed onto wood."

**Breathe With Ease**

Imam and his colleagues weren't just thinking of farmers who would like to see increased demand for commodities such as corn. People working in wood industries and consumers might also benefit.

The researchers developed a process to make a flowable, strong, and moisture-resistant adhesive from a combination of cornstarch, polyvinyl alcohol, latex, and citric acid. The main safety benefit: The process required no volatile formaldehydes or phenols found in conventional wood adhesives. That could be a major selling point for wood products companies—indoor air quality that poses less health risk to workers.

Residents of new and recently furnished homes and offices might also breathe a sigh of relief knowing the products surrounding them contain fewer toxic chemicals. Pressed wood products, especially those made with urea formaldehyde resins and having edges not fully covered by a water-repellent finish, may emit unacceptably high levels of toxic compounds into humid indoor environments that are poorly ventilated.

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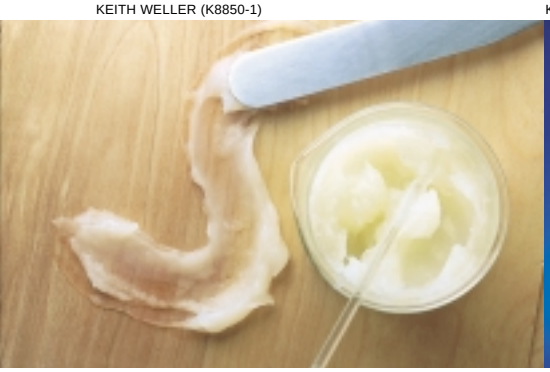

**Starch adhesive being applied to a plywood veneer.**

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**Pellets of sticky extruded material.**

A fire retardant could be added to composite wood products made with starch adhesive. This could be useful for kitchen counter tops where many destructive fires begin. But should the new-style wood composites burn anyway, they would not produce fumes as toxic as those from products containing formaldehyde and phenols.

Because of environmental interests, several U.S. companies as well as the United Nations Industrial Development Organization and the International Center for Science and High Technology, Trieste, Italy, have expressed interest in the new adhesive.

How expensive is it to make this safer glue? Given present prices for ingredients, the cost of making it may be 25 to 30 cents per kilogram more than the cost to make conventional adhesives, according to Lijun Mao, a senior scientist for Planet Polymer Technologies, Inc., San Diego, California.

**Binding Strength**

Owens Corning has been evaluating Imam's adhesive under a materials transfer agreement. "We're conducting further research because the starch adhesive provided excellent bonding strength," said chemist Liang Cheng, a senior scientist who is involved in the company's project to possibly modify current phenolic binder systems.

In his research, Imam and his coworkers used partially melted starch. To a slurry of the starch and dissolved polyvinyl alcohol powder they added the chemical hexamethoxymethylmelamine which, with the help of the catalyst citric acid, firmly bound the starch to the alcohol. Then they added latex to the mix before brushing it on wood. Hot plates pressed the adhesive-covered veneer layers together for 15 minutes.

The latex helped increase the strength of the adhesive bonding and also provided resistance to weakening by moisture. Research still in progress will show whether adding wax to the formulation will further improve water resistance.

Considerable improvement in moisture resistance might be needed to help the plywood stand up in outdoor settings, Imam says. But for conditions harsher than most indoor settings, his birch veneer plywoods measured up to commercial ones. In these tests, he first stored the plywood samples at normal or high humidities for a month or soaked them in water for 2 hours. Then he measured the force needed to pull the layers apart. In 98 percent of samples from each of the storage environments, the adhesive proved stronger than the wood.

More research is needed to determine the commercial potential of the new adhesive. Accordingly, ARS is seeking cooperators to speed the technology for defined uses. A cooperative research and development agreement (CRADA), for example, might entail temporary use of a company's scaled-up research equipment in a recently renovated NCAUR pilot plant.—By **Ben Hardin,** ARS.

*This research is part of New Uses, Quality, and Marketability of Plant and Animal Products, an ARS National Program (#306) described on the World Wide Web at http://www.nps.ars.usda.gov/programs/cppvs.htm.*

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