Modelling water uptake in wood opens up new design framework

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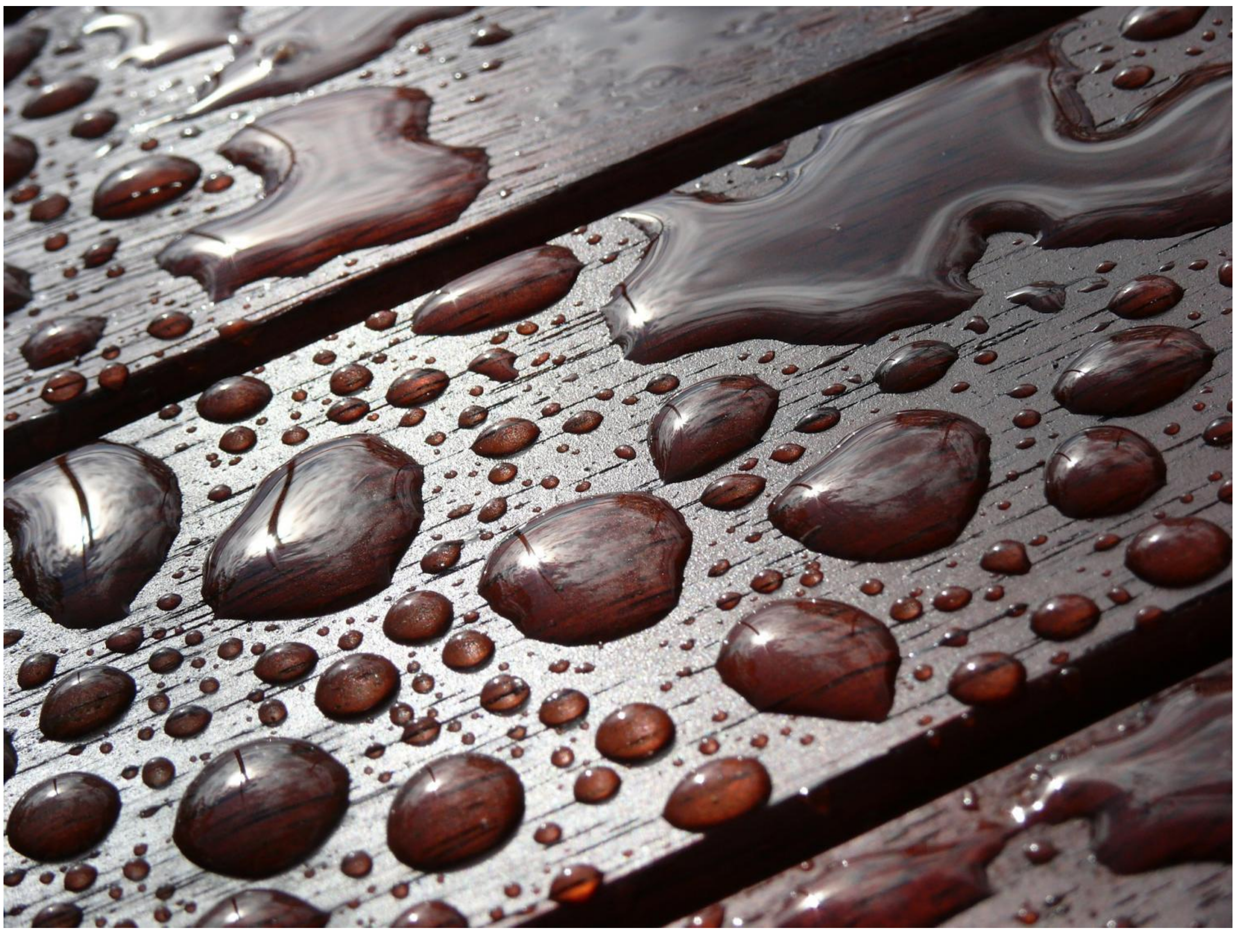

Water on wood. Credit: CCO image

Analytical approach could accelerate the development of new preservation treatments delivering environmental benefits and help in the design of bio-inspired smart actuators.

Wood is a highly complex biological system and its mechanical performance is strongly linked to the interaction of water with the cell walls—a key component of the structure. Our understanding of this versatile material relies heavily on extensive experimental programmes involving thousands of tests and carefully prepared samples. However, let's imagine you could predict the water uptake of treated wood with a simple analytical model—what new prospects would this open up in addition to reducing the burden on testing facilities and wasted materials? Researchers in Germany and France have kick-started this process by presenting an equation of state for wood in the latest issue of the journal *New Journal of Physics*.

"Equations of state are powerful tools that can be used to predict the phase behaviour of complex systems," said Luca Bertinetti of the Max Planck Institute of Colloids and Interfaces (MPIKG) in Germany. "To give an example, the development of such an equation for liposomes in the 1970s has led to huge progress in creams and is now a fundamental to the formulation of products in the personal care industry."

Bertinetti and his colleagues on the project—Peter Fratzl, MPIKG's director, and Thomas Zemb, who is head of the Institut de Chimie Séparative de Marcoule in France—believe that their mathematical model could help the timber industry in developing much more environmentally friendly preservation treatments for wood.The details provided by the equation of state put the research community in a much stronger position to fully understand the molecular mechanisms driving water sorption in wood. In turn, this knowledge will help developers to formulate ways of turning these processes on or off so that water uptake can be either promoted or avoided at specific humidity ranges - a much more elegant alternative to simply coating the wood with coal tar. Also, the insights go beyond wood preservation.

Using the results presented in the paper, it's possible to compute an energy balance for passive, fully reversible, water driven actuation in plant cell walls. This is useful as many plants rely on this behaviour to disperse their seeds and germinate. What's more, device makers are looking closely at the process to develop smart actuators that respond to external stimuli such as changes in humidity. "By describing this behaviour mathematically, we can calculate how much energy could be extracted by employing these systems as actuators working within a given relative humidity range," added Bertinetti.

More information: "Chemical, colloidal and mechanical contributions to the state of water in wood cell walls" Bertinetti et al 2016 *New Journal of Physics* 18 083048, DOI: 10.1088/1367-2630/18/8/083048

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