New genetically engineered wood can store carbon and reduce emissions

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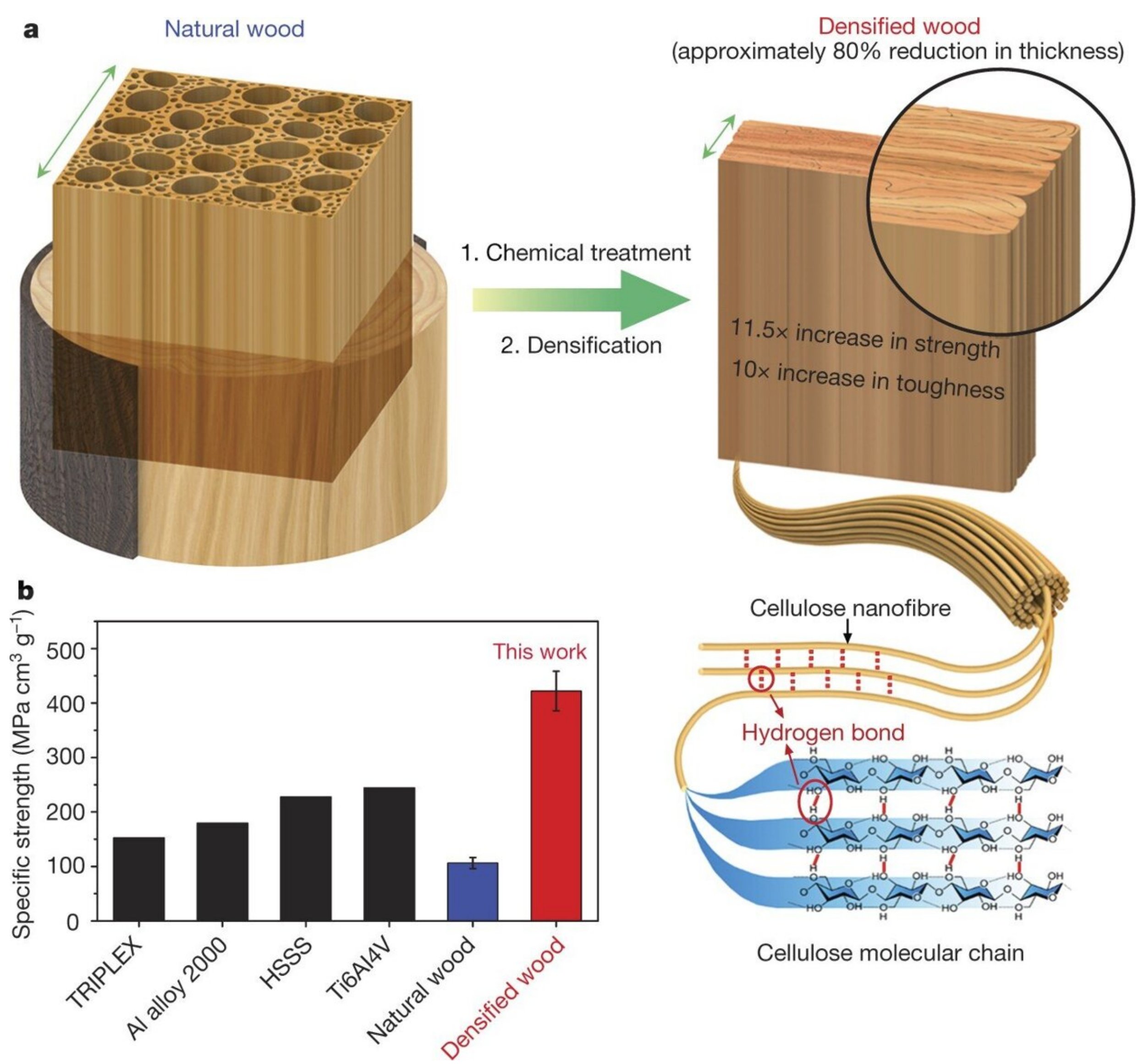

Processing approach and mechanical performance of densified wood. Credit:

Matter (2024). DOI: 10.1016/j.matt.2024.07.003

Researchers at the University of Maryland genetically modified poplar trees to produce high-performance, structural wood without the use of chemicals or energy-intensive processing. Made from traditional wood, engineered wood is often seen as a renewable replacement for traditional building materials like steel, cement, glass and plastic. It also has the potential to store carbon for a longer time than traditional wood because it can resist deterioration, making it useful in efforts to reduce carbon emissions.

But the hurdle to true sustainability in engineered wood is that it requires processing with volatile chemicals and a significant amount of energy, and produces considerable waste. The researchers edited one gene in live poplar trees, which then grew wood ready for engineering without processing.

The research was published online on August 12, 2024, in the Journal *Matter*.

"We are very excited to demonstrate an innovative approach that combines genetic engineering and wood engineering, to sustainably sequester and store carbon in a resilient super wood form," said Yiping Qi, a professor in the Department of Plant Science and Landscape Architecture at UMD and a corresponding author of the study. "Carbon sequestration is critical in our fight against climate change, and such engineered wood may find many uses in the future bioeconomy."

Before wood can be treated to impart structural properties such as increased strength or UV resistance, which allows it to be substituted for steel or concrete, it must be stripped of one of its main components, called lignin.

Previously, UMD researchers successfully developed methods for removing lignin using various chemicals, and others have explored the use of enzymes and microwave technology. With this new research, Qi and his colleagues sought to develop a method that does not rely on chemicals, produce chemical wastes or rely on large amounts of energy.

Using a technology called base editing to knock out a key gene called 4CL1, the researchers were able to grow poplars with 12.8% lower lignin content than wild-type poplar trees. This is comparable to the chemical treatments used in processing engineered wood products.

Qi and his collaborators grew their knock-out trees side by side with unmodified trees in a greenhouse for six months. They observed no difference in growth rates and no significant differences in structure between the modified and unmodified trees.

To test the viability of their genetically modified poplar, the team, led by professor of materials science and engineering, Liangbing Hu, used it to produce small samples of high-strength compressed wood similar to particle board, which is often used in building furniture.

Compressed wood is made by soaking wood in water under a vacuum and then hot-pressing it until it is nearly 1/5 of its original thickness. The process increases the density of the wood fibers. In natural wood, lignin helps cells maintain their structure, and prevents them from being compressed. The lower lignin content of chemically treated or genetically modified wood allows the cells to compress to a higher density, increasing the strength of the final product.

To evaluate the performance of their genetically edited trees, the team also produced compressed wood from the natural poplar, using untreated wood and wood that they treated with the traditional chemical process to reduce the lignin content.

They found that the compressed genetically modified poplar performed on a par with the chemically processed natural wood. Both were denser and more than 1.5 times stronger than compressed, untreated, natural wood.

The compressed genetically modified wood had a tensile strength comparable to aluminum alloy 6061 and the compressed wood that had been chemically treated.

This work opens the door to producing a variety of building products in a relatively low-cost, environmentally sustainable way at a scale that can play an important role in the battle against climate change.

More information: Genome-Edited Trees for High-Performance Engineered Wood, *Matter* (2024). DOI: 10.1016/j.matt.2024.07.003. www.cell.com/matter/fulltext/S2590-2385(24)00396-5

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