By design: From waste to next-gen carbon fiber

18 August 2022, by Brandie Jefferson

Researchers knew that, combined with polyacrylonitrile (PAN), the newly designed HiMWELL lignin could become a precursor to a better carbon fiber and that it could enable the development of recyclable plastics with better properties, as well.

Already, carbon fiber is known for being a strong and stiff, yet light—and premium—material. It is used as structural reinforcement in everything from tennis rackets to airplanes, and carbon fiber frames reduce weight and improve safety in high-end vehicles. It has been incorporated anywhere possible in some of the fastest super and hypercars.

Yuan's previous work identified three main roadblocks to incorporating lignin in the equation: neither lignin's chemical structure nor its molecular weight is uniform, which makes it difficult to combine with other polymers. And it has a high number of OH groups, a reactive pairing of oxygen and hydrogen that attracts water—not ideal for building a rigid material like carbon fiber. These discoveries inspired Yuan and Jinghao Li, a senior scientist at Washington University, to redesign lignin structures.

By developing a technique to chemically alter these properties, Yuan said, "We've really created a type of lignin that is very unique."

When combined with PAN, the HiMWELL-based carbon fiber had a record tensile strength and showed better mechanical properties than standard carbon fiber. When it was added to recyclable polymer blends, HiMWELL improved mechanical properties and also improved UV protection.

"Finally, we have a technological path for lignin to be used for carbon fibers," Yuan said. And perhaps one day, "You'll turn this waste into the shell of a...
car."


Provided by Washington University in St. Louis

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