New Strategy Leverages Lignin Condensation for Biomass Utilization

There is an old saying in the biorefining industry that "You can make anything from lignin except money." This bio-based compound is abundant and full of potential, but commercializing it remains a challenge.

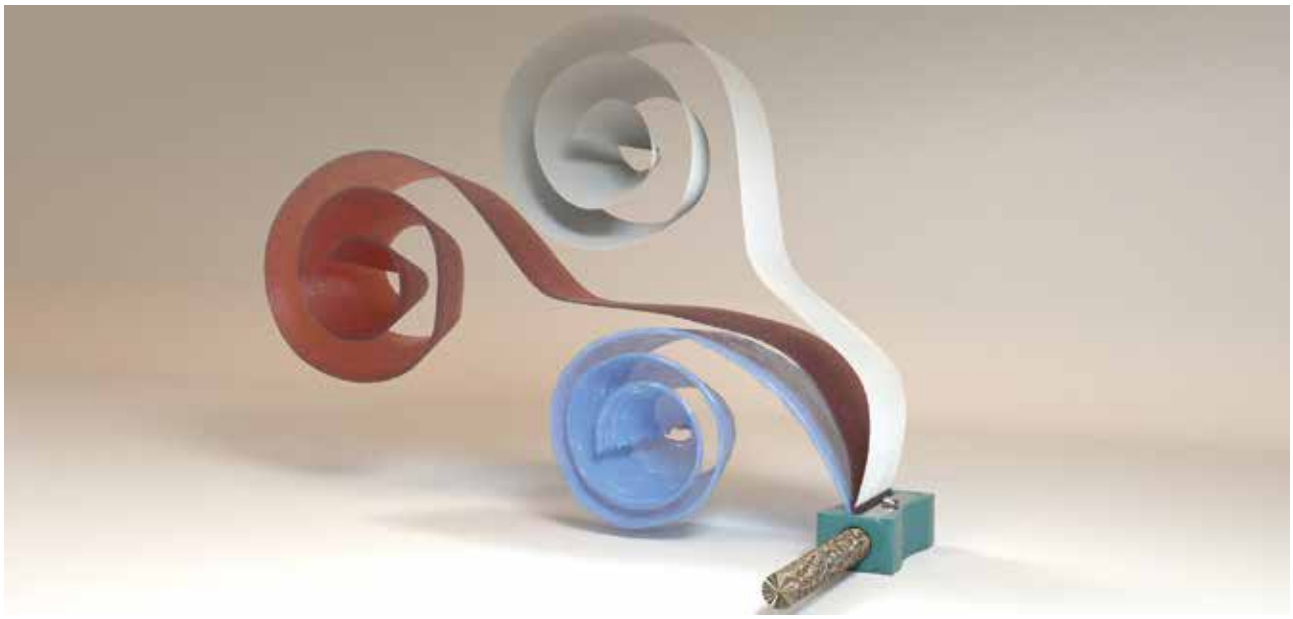
This may no longer be the case soon with an innovative approach by chemists from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences and their colleagues to harness lignin condensation – often considered a nuisance – for efficient utilization of lignocellulose. This opens a holistic pathway for maximizing the potential of wood biomass and advancing towards a more sustainable future.

Their results were published in *Nature* on May 29.

Lignin is a complex polymer in lignocellulose – a structural component found in the cell walls of plants and a potential organic feedstock for the production of biofuel and bio-based material. However, when chemically treated, lignin tends to form new C–C bonds, a process known as condensation, which makes its structure complex and less reactive. This hampers further processing and consequently limits the effective utilization of lignocellulose to produce green chemicals and materials.

Various efforts have been made to sidestep this detrimental condensation. The researchers at DICP, howev-

Schematic illustration of harnessing condensed lignin from wood.



Graphic: DICP

er, went against the grain and found a way to use lignin condensation to their advantage.

"Rather than suppressing the undesired reaction, we aimed to leverage lignin's proclivity toward condensation by restructuring the condensation reaction pathway through explicit arylation with lignin-derived phenols," said Dr. WANG Feng, a researcher at DICP and the corresponding author of this study.

Arylation is a chemical process in which an aryl group, a type of aromatic compound, is introduced into a molecule via Friedel-Crafts Alkylation. By directing specific bond formations through this process, the researchers were able to obtain a high yield of condensed lignin, which was further processed to produce benign bisphenols – versatile compounds with applications ranging from plastics to adhesives that could serve as potential replacements for fossil-based counterparts.

"Historically, lignin has been viewed as waste or a hindrance in biorefinery processes," WANG said. "However, through our studies, we have come to recognize that lignin is, rather than a waste product, an invaluable and indispensable natural resource for fostering sustainability. Our slogan, therefore, is 'Lignin Matters,' and we advocate for developing strategies to efficiently convert lignin into valuable chemicals and materials."

By maximizing lignocellulose's value, the researchers' approach contributes to a more holistic approach to biomass utilization, aligning with the goals of green biorefineries.

"Our ultimate goal is to establish an industrially competitive biorefinery, revolutionizing the production of renewable chemicals and biomaterials," WANG said. "I hope in the future T-shirts and plastic commodities can be directly manufactured from wood or grasses."

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(Source: DICP)