TURNING LIGNIN INTO VALUABLE PRODUCTS

In a study published in *Nature Catalysis* on May 28, Chinese scientists unveiled a novel approach to transforming lignin, a major component of woody biomass, into valuable chemical products (doi: 10.1038/s41929-024-01165-w). This discovery could pave the way for more sustainable and efficient use of renewable resources.

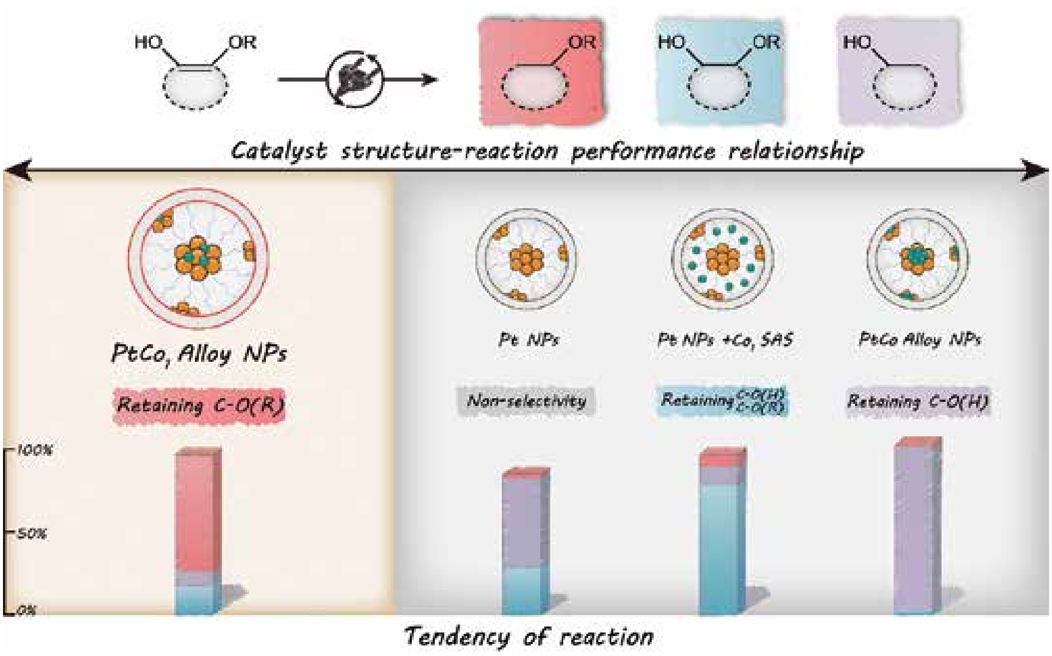
Lignin, often considered the "glue" that holds plant cells together, is one of the most abundant natural sources of aromatic compounds on Earth. However, breaking it down efficiently has long been a challenge for researchers and industry alike.

The team, led by Dr. HAN Buxing and Dr. MENG Qinglei from the Institute of Chemistry of the Chinese Academy of Sciences (ICCAS), developed an innovative electrocatalytic method to convert lignin derivatives into cycloalkyl ethers. This process, known as selective hydrogenation deoxygenation (HDO), represents a significant leap forward in biomass utilization.

What makes this discovery particularly exciting is the catalyst they've engineered. By carefully controlling the interaction between platinum nanoparticles and single-atom cobalt sites on a mesoporous carbon support, the researchers achieved something remarkable: they managed to break the hydroxyl C-O(H) bonds while preserving the ether C-O(R) bonds in lignin-derived molecules.

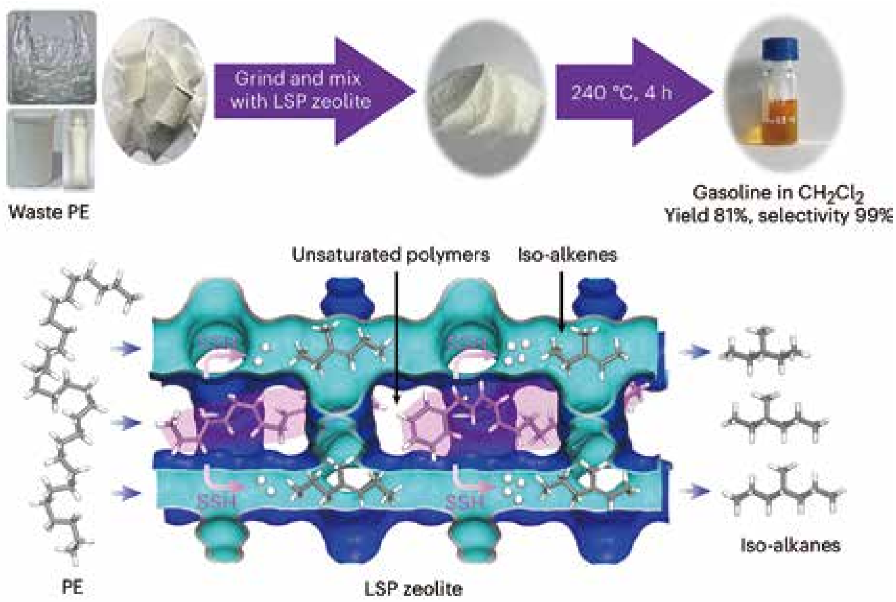
The whole catalytic process mimics performing molecular surgery – selectively cutting certain bonds while leaving others intact, transforming lignin into more valuable compounds.

This breakthrough could have far-reaching implications for industries ranging from biofuels to pharmaceuticals. By offering a greener, more efficient way to process lignin, it opens up new possibilities for creating sustainable chemicals and materials from what was once considered waste.



By finely tuning the interaction (or, the distance) between platinum and cobalt atoms, this innovative catalyst performs precise "molecular surgery" on lignin, transforming wood waste into valuable chemicals.

Graphic: ICCAS



Graphic: ICCAS

Turning plastic bags or waste polyethylene (PE) into premium gasoline using earth-abundant layered self-pillared (LSP) zeolite catalysts.

PLASTIC ALCHEMY

Current cutting-edge methods for breaking down plastic usually need expensive rare metals, use up hydrogen gas, and produce unwanted methane as a byproduct. Now scientists have discovered that earth-abundant layered self-pillared zeolite catalysts can turn plastic bags into high-quality gasoline without needing extra hydrogen. These zeolite catalysts, pulling the trick of plastic alchemy, act like super-efficient recycling factories at the tiny scale.

Their study was published in a recent issue of *Nature Chemistry* on April 9, 2024 (doi:10.1038/s41557-024-01506-z).

Led by Drs. HAN Buxing and LIN Longfei from the Institute of Chemistry of the Chinese Academy of Sciences (ICCAS), the team has achieved what many thought impossible: converting PE into gasoline with a remarkable selectivity of 99% and yields of >80% at 240°C for 4 hours, all without using noble metals, external hydrogen, or solvents.

What is the secret weapon in this plastic alchemy? A specially designed zeolite catalyst with a structure that resembles a microscopic high-rise apartment complex. This layered self-pillared (LSP) zeolite is riddled with tiny pores, creating a vast internal surface area teeming with acidic sites that break down the plastic like a molecular wrecking crew.

But the real magic happens thanks to some clever atomic architecture within the zeolite. Special aluminum atoms, arranged in what scientists call "open Framework Tri-coordinated Al" (oFTAl) species, act like tiny plastic-cracking ninjas, slicing and dicing PE molecules with unprecedented efficiency.

Perhaps the most ingenious part of this process is its self-sufficiency. As the plastic breaks down, some fragments reorganize themselves into ring-shaped molecules, releasing hydrogen in the process. This home-grown hydrogen then helps convert other plastic fragments into high-quality gasoline components. It's like the catalyst is running its own internal recycling program!

A gasoline that's not just eco-friendly in origin but potentially superior in quality. The fuel produced contains twice the concentration of iso-alkanes found in commercial gasoline, which could mean better engine performance and efficiency.

This breakthrough may revolutionize how we deal with plastic waste, turning landfills and ocean garbage patches into potential fuel reserves. It's a step towards a circular economy where yesterday's water bottle could become tomorrow's road trip fuel.

TWO-STEP TRICK TO HACK INTO CELLS

In the microscopic world of viruses and human cells, a high-stakes game of lock-picking is constantly unfolding.

In a recent study published in *Cell* on July 3, researchers from Fudan University, ShanghaiTech University, and the Institute of Biophysics (IBP) under the Chinese Academy of Sciences cracked the code on how one particular coronavirus, HCoV-HKU1, manages to sneak its way into our cells using a cunning two-step approach (doi: 10.1016/j.cell.2024.06.016).

HCoV-HKU1, a lesser-known cousin of the infamous SARS-CoV-2, employs a protein called "spike" as its skeleton key. This spike protein is the virus's primary tool for recognizing and latching onto human cells. But unlike simpler viruses that use a single "lock and key" mechanism, HCoV-HKU1 has evolved a more sophisticated strategy.

Imagine the virus as a safecracker trying to open a high-security vault. First, it needs to disarm the alarm system (represented by sialoglycans, sugar-coated molecules on the cell surface). Once this is done, it can then manipulate the main lock (the TMPRSS2 protein) to gain entry.

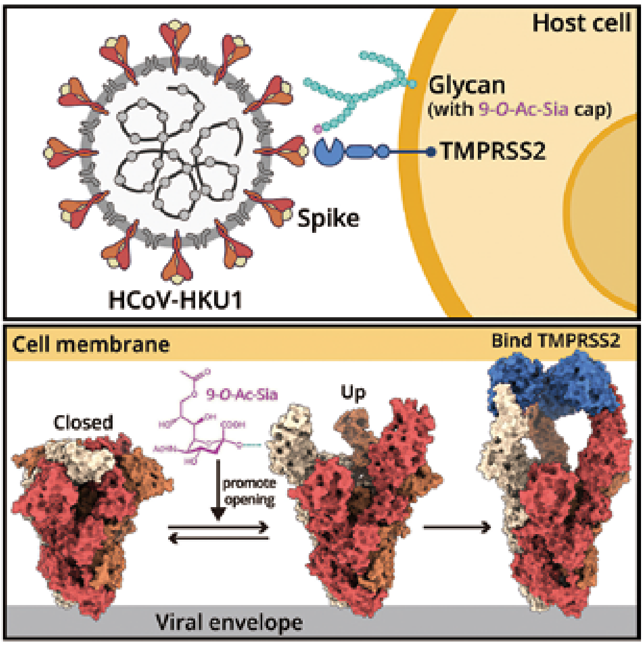
What's fascinating is how the virus uses one interaction to set up the next. When the spike protein binds to sialoglycans, it causes a shape change that primes another part of the spike, called the RBD, to interact with TMPRSS2.

This two-step process involves specific parts of the spike protein. The NTD (N-terminal domain) interacts with sialoglycans, triggering a change that allows the RBD (receptor-binding domain) to open up and bind to TMPRSS2. The RBD has a unique inserted section that forms three separate contact points with TMPRSS2, ensuring a secure attachment.

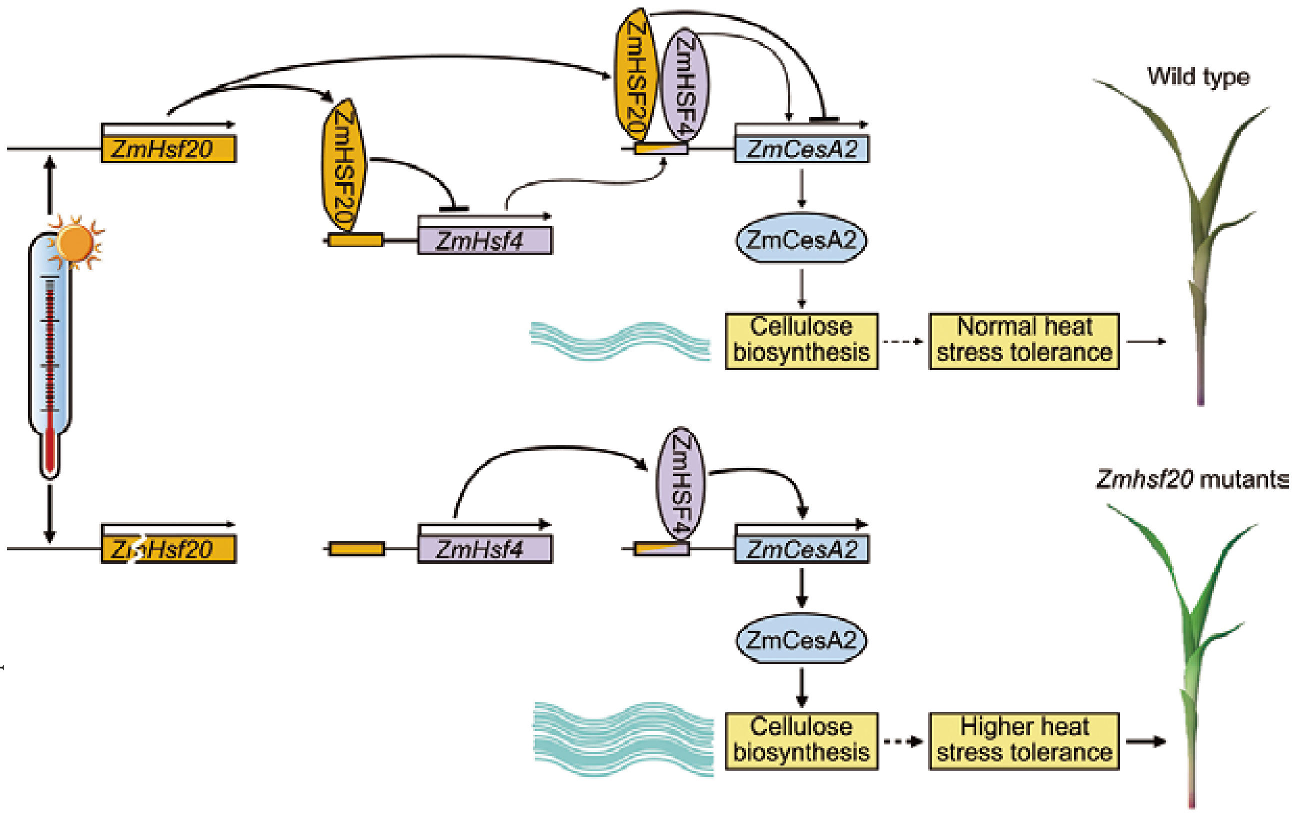
The research team used advanced imaging techniques to capture the spike protein in three different states: inactive, activated by glycans, and fully engaged with the cell. This allowed them to piece together the entire entry process, revealing how each step influences the next.

Though this study focuses on HCoV-HKU1, the findings have broader implications since this entry mechanism is conserved across different variants of the virus. This new understanding of viral entry mechanisms could prove crucial in the ongoing battle against coronavirus-associated diseases. By identifying the key players and steps in the process, researchers can now work on developing targeted therapies that disrupt this intricate entry dance, potentially stopping infections before they start.

How an HCoV-HKU1 virus enters a human cell in a two-step process – an example of using one interaction to set up the next.



Graphic: Wang *et al.*



Graphic: IBCAS

The malfunction of a particular gene called *ZmHsf20* confers heat-tolerance in maize.

HOW MAIZE COPES WITH HEAT STRESS

In a study published in the journal *Plant Cell* on April 4, researchers from the Institute of Botany of the Chinese Academy of Sciences (IBCAS), pinned down the core genes that regulate maize's heat stress response (doi: 10.1093/plcell/koae106). This discovery comes at a crucial time as global warming threatens crop yields worldwide.

Maize, China's number one grain crop with an annual production of 250 million tons, plays a vital role in ensuring food security. However, as heatwaves become more frequent and intense, maize crops are increasingly at risk.

Dr. ZHANG Mei and her team found that a particular gene, called *Zmhsf20*, works as a tiny genetic switch to control maize crop's response to heat stress. By creating mutant plants with malfunctional *Zmhsf20*, they stumbled upon a surprising result – these modified plants were significantly more heat-tolerant than their normal counterparts.

It's like they've discovered maize's internal air conditioning system. By removing *ZmHSF20*, they essentially allowed the plant to crank up its cooling mechanism full blast.

But the story doesn't end there. The researchers also identified two more genes, *ZmHsf4* and *ZmCesA2*, that work together like a tag team to boost heat resistance by relaying the work from ZmHSF20. These genes help strengthen the plant's cell walls, making them more stable under high temperatures – imagine giving maize a heat-resistant suit of armor.

To visualize this process, picture a microscopic construction site within the maize plant. When ZmHSF20 is removed, ZmHsf4 and ZmCesA2 become the enthusiastic foremen, directing the building of stronger, more heat-resistant cell walls.

This discovery may open exciting possibilities for developing heat-resistant maize varieties, a crucial step in adapting agriculture to our changing climate.