Upcycling Industrial Biomass Wastes Into Aerogels UsingZinc Chloride Salt Hydrates

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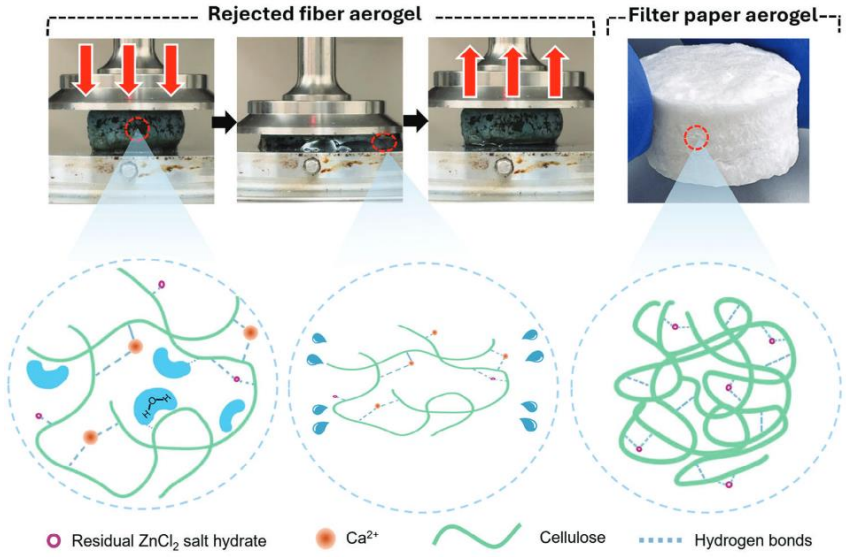


***Advanced Sustainable Systems* 2025,**
https://doi.org/10.1002/adsu.202400688
Mairui Zhang, Yang Liao, Nara Han, Seoku Lee, Gyu Leem, Kwang Ho Kim, Xuejun Pan,Jeong Jae Wie, and Chang Geun Yoo

Scientific Achievement

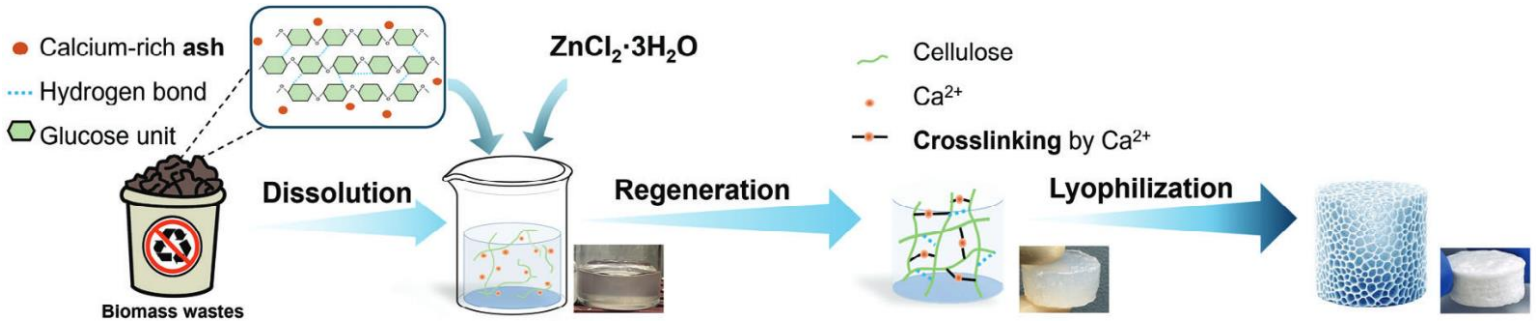
Developed a direct upcycling strategy to convert unrecyclable industrial biomass wastes (rejected fibers, food-contaminated paper) into high-performance cellulose aerogels.

Significance and Impact

- Demonstrates, that industrial waste impurities can positively participate in cellulose network formation, rather than hindering material fabrication
- Provides a cost-effective and scalable pathway for aerogel production without purification, organic solvents, or additional cross-linkers

Research Details

- Direct and purification-free upcycling strategy that converts unrecyclable paper-based biomass wastes into high-performance cellulose aerogels, leveraging intrinsic calcium impurities as in situ cross-linkers to enhance mechanical strength and thermal insulation without additional chemicals or organic solvents.



Novel Biorefinery Approach through a Biocompatible Deep Eutectic Solvent-Mediated One-Pot Mechanochemical Conversion

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Energy Fuels **2025, 39, 30, 14645–14653**
Maria Lauren, Nara Han, Chang Geun Yoo, Keunhong Jeong, Bonwook Koo, Kwang Ho Kim

Scientific Achievement

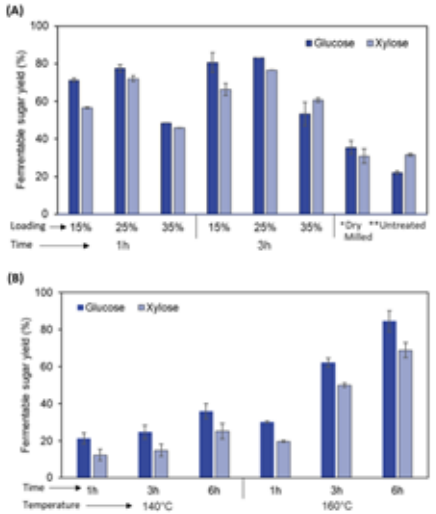
Through synergistic mechanochemical approach, we achieved high glucose yields from corn stover at high solid loading, under ambient conditions and without the need for heating, washing, or pH adjustment.

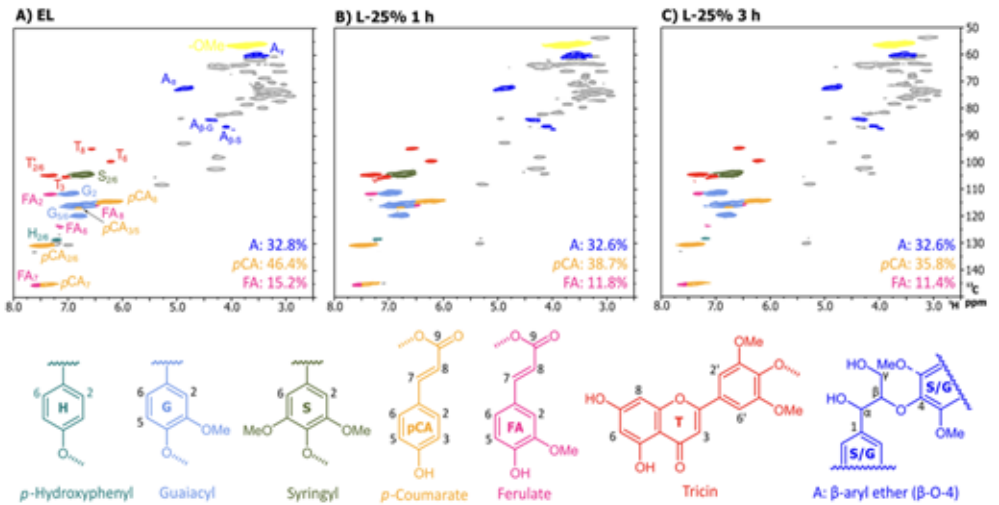
Significance and Impact

A sustainable and efficient biomass conversion strategy integrating a green, biocompatible deep eutectic solvent (DES) with a mechanical ball-milling pretreatment to enable high-solid-loading, one-pot processing under ambient conditions was developed.

Research Details

- Up to 83% of glucose yield from corn stover at 25wt% loading.
- Sugar yields remained high without external heat, pressure, or an intermediate washing step.
- Preserved near-complete native lignin structure, which is beneficial for its post-processing.





Effects of chemical composition and physicochemical properties of poplar biomass on the performance of 3D printed poplar-reinforced PLA materials

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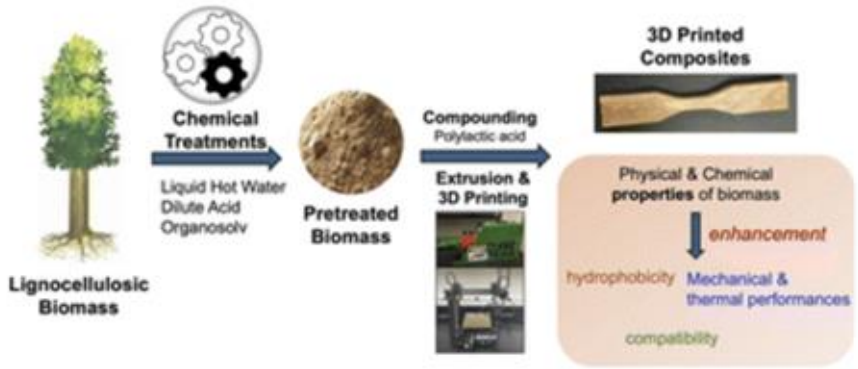


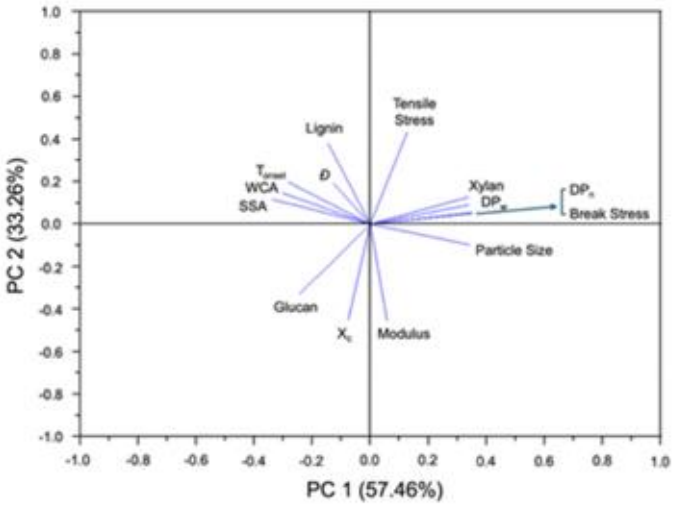
***RSC Sustainability* 2025, Accepted**
Anqi Ji, Samarthya Bhagia, Nara Han, Kwang Ho Kim, Gyu Leem, Nidia C. Gallego, Shuyang Zhang, Kai Li, Soydan Ozcan, Arthur J. Ragauskas, Chang Geun Yoo

Scientific Achievement

We investigated the relationships between biomass characteristics and 3D printed composite behaviors to provide guidance for optimizing biomass processing in biocomposite applications.

Significance and Impact

The current understanding of the relationships between biomass properties and composite performance can be used to design the targeted biomass processing approach based on the required properties and performance. Furthermore, additional modifications of biomass feedstock can be made based on the findings of this study to enhance the biocomposite properties.



Research Details

- The specific surface area and water contact angle of biomass contributed to the thermal stability of biocomposites.
- The degree of polymerization of cellulose and xylan content within the biomass correlated with the biocomposites' break stress.
- The crystallinity of biocomposites impacted the modulus of these materials.

Upgrading polyethylene plastic waste into a biodegradable polymer: Harnessing a hybrid chemical oxidation–biological conversion approach

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***Chemical Engineering Journal* 2025, 504, 158823**
Siti Nurjanah Firmansyah, Habin Sun, Chun-Jae Yoo, Ja Kyong Ko

Scientific Achievement

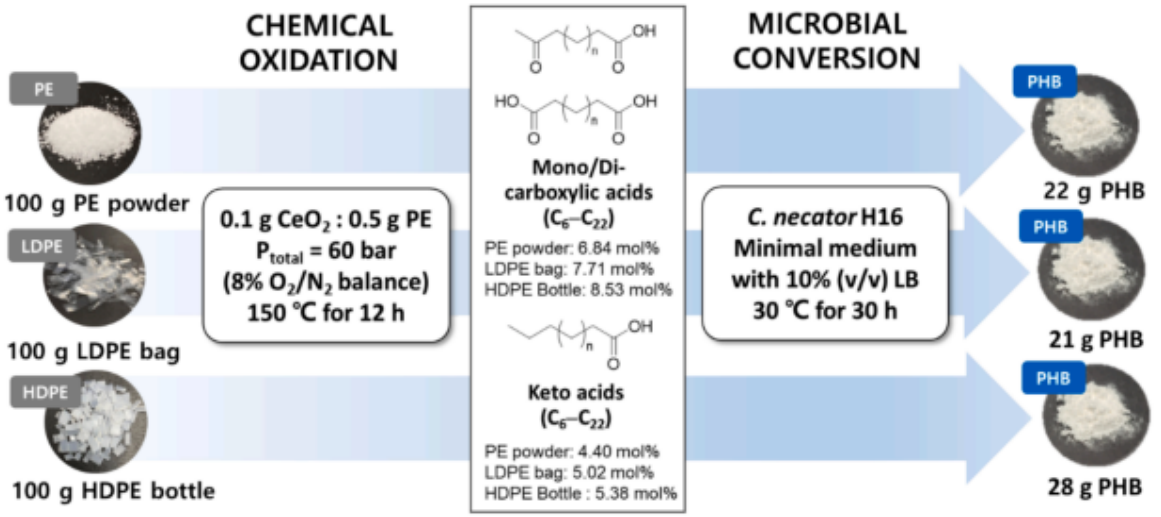
This study establishes a hybrid chemical–biological process that converts polyethylene waste into the biodegradable polymer PHB, achieving up to 0.28 g PHB per g PE. The work demonstrates an efficient strategy to transform recalcitrant plastic into value-added biopolymers.

Significance and Impact

By integrating mild chemical oxidation with microbial conversion, this approach provides a sustainable pathway to upcycle polyethylene into biodegradable materials, advancing circular plastic economy technologies.

Research Details

- Polyethylene waste was efficiently oxidized under mild conditions using a CeO_2 catalyst to generate bioavailable intermediates.
- The resulting oxidation products were converted by *Cupriavidus necator* H16 into PHB with yields up to 0.28 g/g PE, the highest reported among chemical–biological PE conversion methods.



Engineering xylose utilization in *Cupriavidus necator* for enhanced poly(3-hydroxybutyrate) production from mixed sugars

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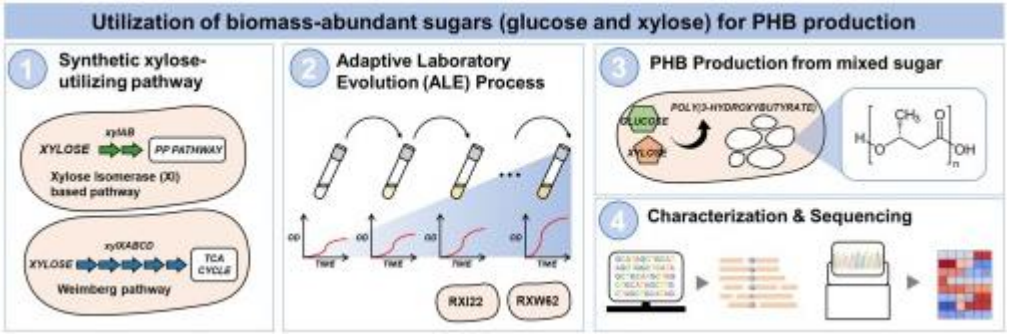


***Bioresource Technology* 2025, 418, 131996**
So Jeong Lee, Jiwon Kim, Jung Ho Ahn, Gyeongtaek Gong, Youngsoon Um, Sun-Mi Lee, Kyoung Heon Kim, Ja Kyong Ko

Scientific Achievement

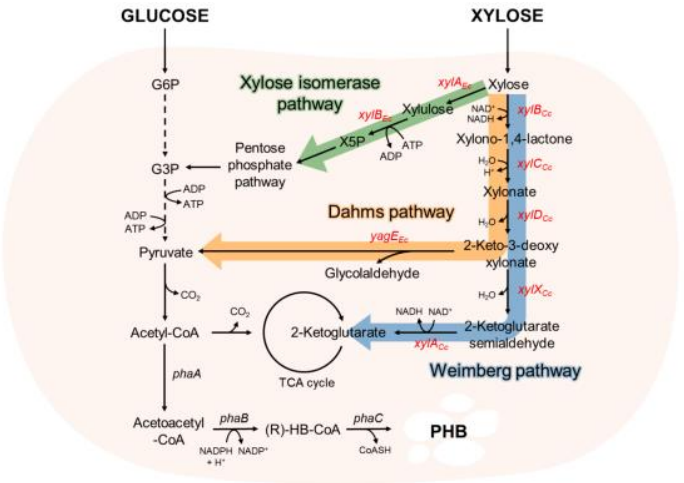
This study engineered *Cupriavidus necator* to efficiently utilize xylose, enabling enhanced PHB production from mixed glucose–xylose substrates. The work expands substrate utilization and improves biopolymer production from lignocellulosic sugars.

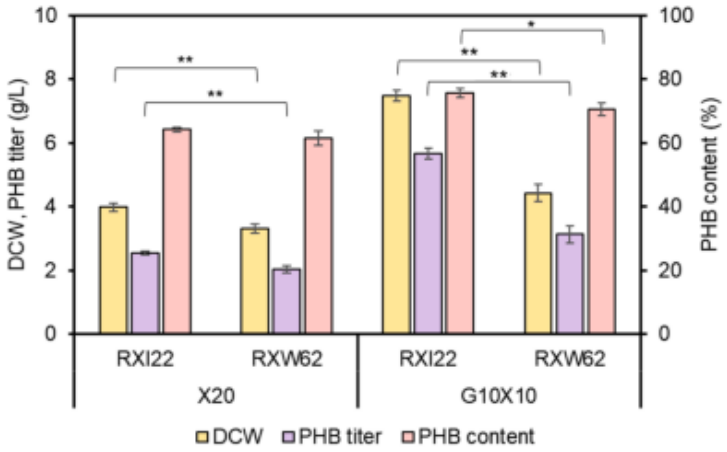
Significance and Impact

By enabling effective conversion of pentose-rich biomass into biodegradable PHB, this study advances the economic feasibility and sustainability of bio-based plastic production.

Research Details

- Synthetic xylose metabolic pathways were introduced into *Cupriavidus necator* NCIMB11599 to enable xylose utilization.
- The engineered strains RXI22 and RXW62 efficiently produced up to 64.2 wt% and 61.4 wt% PHB from xylose as the sole carbon source.
- RXI22 achieved 75.7 wt% PHB and a yield of 0.32 g/g from mixed glucose–xylose substrates.





Lignification-mimetic dehydrogenative diphenoquinone synthesis and electrochemical CO_2 capture

***Green Chemistry* 2026, 28, 2408-2421**
Hyeyu Kim, Omer Shinnawy, Seda Ulusoy, German Salazar-Alvarez, Ngoc Tuan Tran, Hyesung Cho, Changmin Sung, Seung-Soo Kim, Bonwook Koo, Keunhong Jeong, Kiana Amini, Kwang Ho Kim

Scientific Achievement

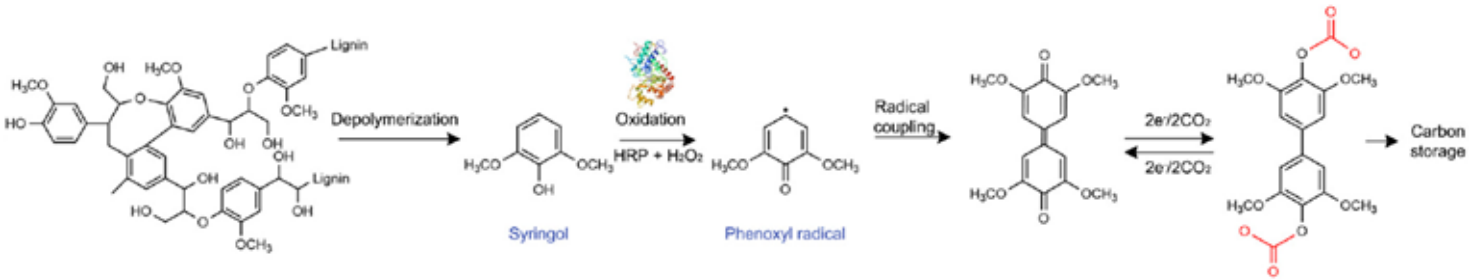
Developed a biomimetic, enzymatic synthesis of a crystalline lignin-derived diphenoquinone and demonstrated its first application as a renewable redox-active material for electrochemical CO_2 capture.

Significance and Impact

- Demonstrates a renewable, enzymatically synthesized quinone platform for electrochemical CO_2 capture
- Advances lignin valorization from bulk materials to high-value redox-active molecules
- Enables electricity-driven carbon capture under mild conditions with measurable capacity (1.9 mmol g^{-1})

Research Details

- Synthesized a crystalline C4–C4′ diphenoquinone dimer from syringol via one-pot peroxidase catalysis (~90% yield) under mild aqueous conditions
- Demonstrated quasi-reversible $2e^-/2H^+$ redox behavior and electrochemically triggered CO_2 capture/release (1.9 mmol g^{-1})



Hydrophobic and mechanically reinforcing coatings from palmitoylated lignin via waterborne spraying

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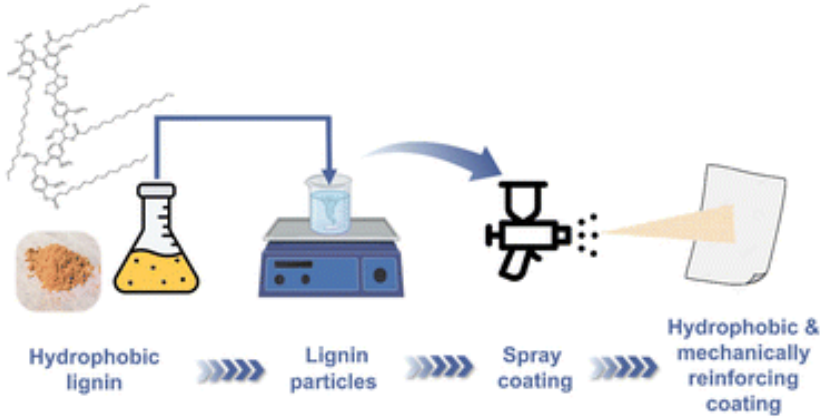


***Green Chemistry* 2026, 28, 1924-1934**
Jie Wu, Nathan Huang, Daniel Barker-Rothschild, Zhangmin Wan, Minke Yang, Xin Shu, Yi Hu, Joshua Booth, Oliver Everden, Orlando Rojas, Kwang Ho Kim

Scientific Achievement

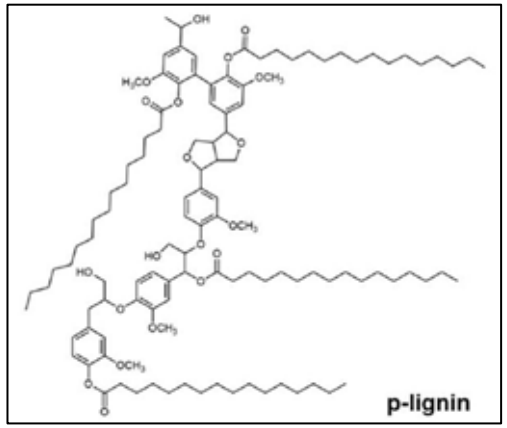
Developed a fully bio-based lignin-derived hydrophobic coating using green chemical modification and surface engineering to achieve high water repellency without fluorinated or silicone additives.

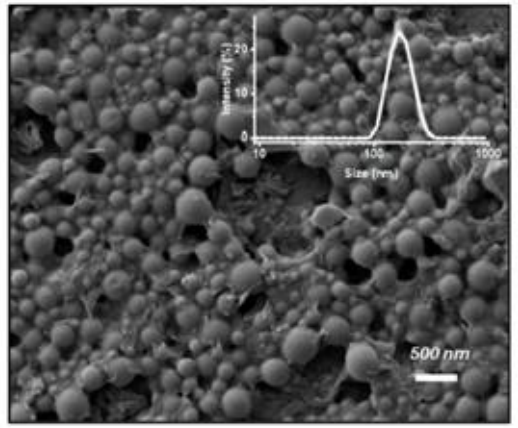
Significance and Impact

- Provides a sustainable alternative to fluorinated hydrophobic coatings for packaging and surface protection
- Demonstrates value-added lignin utilization beyond combustion or filler applications
- Enables scalable, solvent-efficient surface modification compatible with industrial substrates

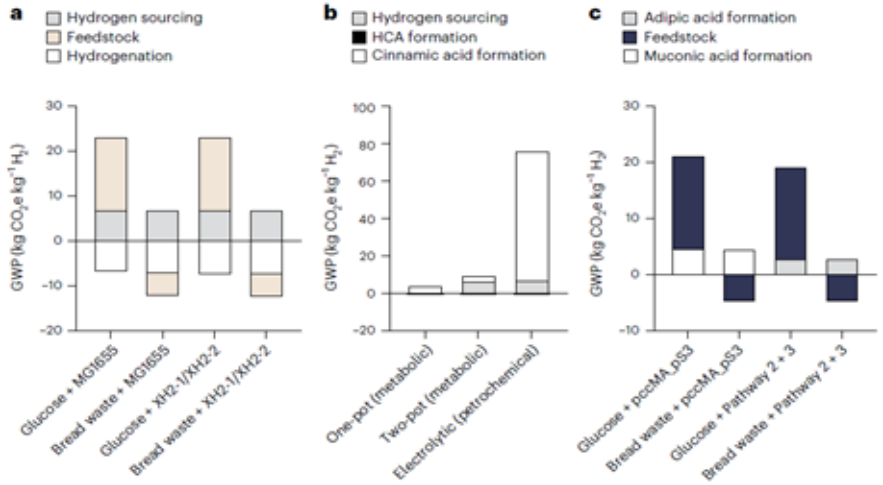
Research Details

- Chemically modified lignin via fatty-acid grafting (e.g., palmitoylation) to increase intrinsic hydrophobicity





Native H_2 pathways enable biocompatible hydrogenation of metabolic alkenes in bacteria



***Nature Chemistry* 2026,** https://doi.org/10.1038/s41557-025-02052-y

White M., Trotter C., Lau E., Steele J., Sadhukhan J, Era Y., Law S., Gilman J., Dennis J., Johnson N., Gordon R., Wallace S.

Scientific Achievement

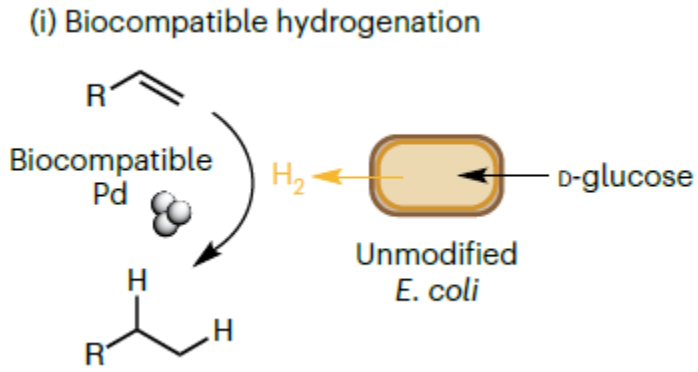
By coupling engineering biology, catalytic green chemistry and life cycle assessment, the study delivers a scalable platform for carbon-negative chemical manufacturing from renewable/waste feedstocks.

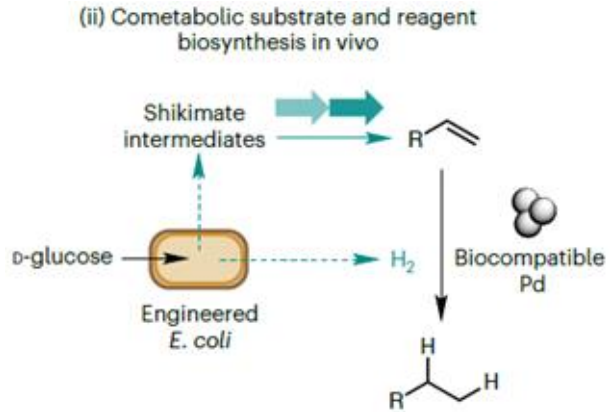
Significance and Impact

- Demonstrates, for the first time, that *native microbial H_2 metabolism* can directly drive hydrogenation in living cells
- Enables membrane-localized catalytic transformations to generate new-to-nature products from simple carbon sources
- Shows that chemo-microbial systems using bread waste achieves *lower greenhouse gas emissions and carbon-negative outcomes*

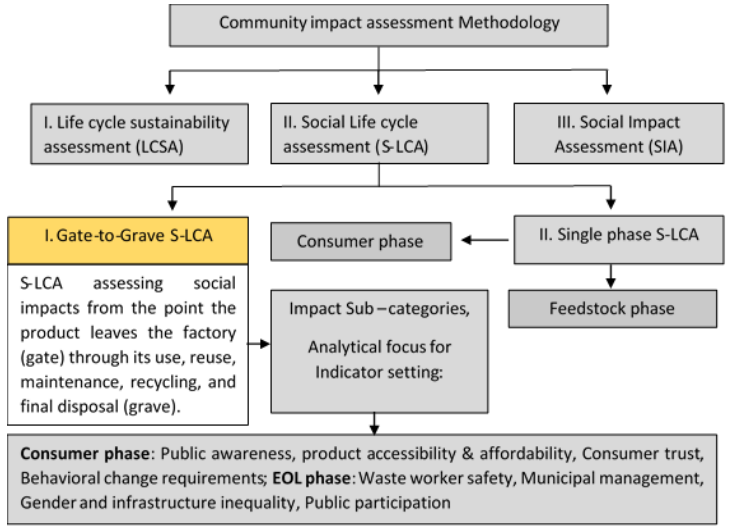
Research Details

- *E. coli* (unmodified and engineered) produces alkenes, which are bio-reduced in vivo into metabolite products by membrane-bound biocompatible Pd catalysis





Gate-to-Grave Social Life Cycle Assessment (S-LCA) of Bioproducts — Research Methodology refinement



Community impact assessment research Framework

Scientific Achievement

This study establishes research framework refinement from a broader community impact assessment into a structured Gate-to-Grave Social Life Cycle Assessment (S-LCA) for bioproducts. The work demonstrates a systematic approach to evaluate life-cycle-based social impacts by integrating stakeholder-specific indicators across consumption, use, and end-of-life stages.

Significance and Impact

Refinement strengthens methodological rigor and comparability, converting prior community insights into a product-system assessment that identifies social hotspots. Outputs will inform policy-relevant insights and improve end-of-life social outcomes.

Research Details

- Conducted comparative review of methods Life Cycle Sustainability Assessment (LCSA), S-LCA, and Social Impact Assessment (SIA) to finalize this system boundary and formalized stakeholder groups (consumers, waste-management workers, municipal officials, local communities)
- A mixed-method protocol has been developed: online and in-person surveys (Edmonton 150; Calgary 150; total ≈ 300) and qualitative interviews (consumers, waste-management workers, municipal officials; total ≈ 50), with instruments explicitly mapped to Gate-to-Grave S-LCA indicators.
- Preliminary indicator mapping have been studied to ensure consistency with S-LCA stakeholder categories and life-cycle stages.
- Research Ethics amendment submitted to expand survey participation to the general public as bioproduct consumers.