# Hydro-Torsional Compaction for High-Performance Aramid Nanofiber Threads

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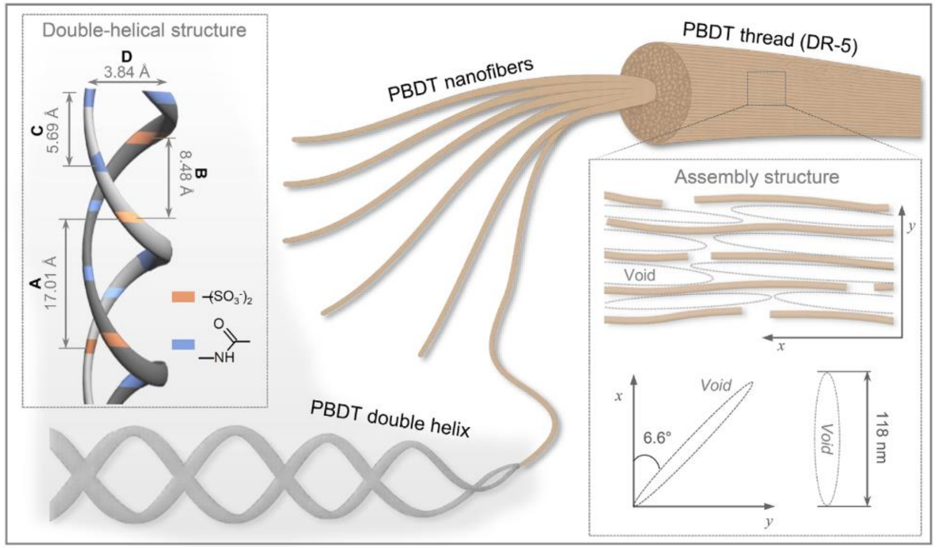
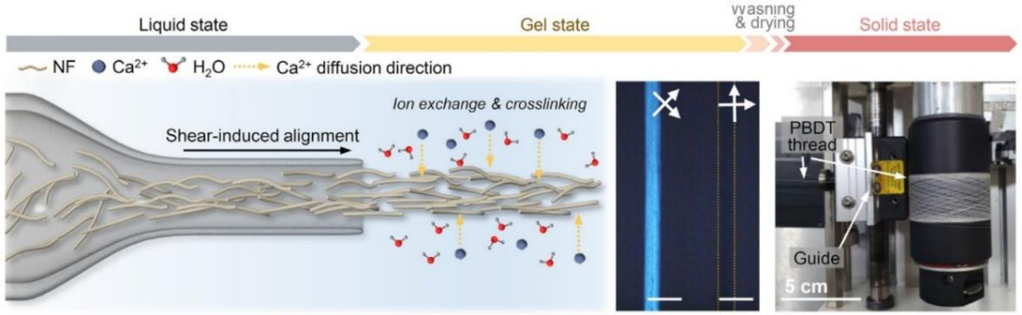
## Significance and Impact

- Demonstrates a scalable route for manufacturing high-performance aramid nanofiber threads using aqueous processing.
- Achieves mechanical properties approaching or exceeding those of natural spider silk and many advanced synthetic fibers.
- The reversible ionic crosslinking network provides potential recyclability and closed-loop manufacturability.




## Research Details

- $Ca^{2+}$ ionic crosslinking stabilized aligned nanofiber networks and enhanced packing density.
- Increasing draw ratio improved nanofiber orientation and reduced microvoid misalignment, significantly enhancing mechanical properties.
- Mechanical performance surpassing many synthetic and bio-derived fibers.




## Scientific Achievement

- PBDT nanofiber threads were fabricated through $Ca^{2+}$-mediated wet spinning followed by mechanical drawing (DR 1–5).
- Structural alignment and densification were enhanced using a humidity-assisted twisting (hydro-torsional compaction) process.

Jeong, W. et al. Adv. Mater. (2026); DOI: 10.1002/adma.72889

# Dynamic Circular Sulfur-Rich Polymer Glasses From Elemental Sulfur

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## Significance and Impact

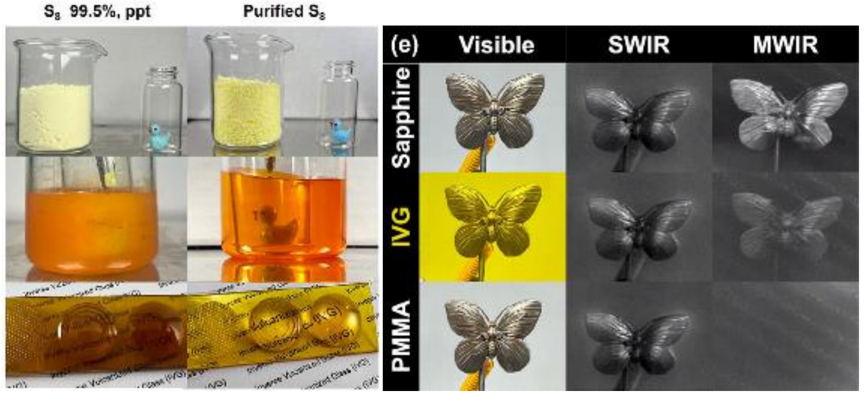
- Demonstrates a scalable and sustainable strategy for converting inexpensive elemental sulfur into high-value optical materials.
- Enables circular manufacturing through dynamic covalent bond-mediated recyclability. Provides lightweight broadband optical materials for visible and infrared applications, including precision lenses.

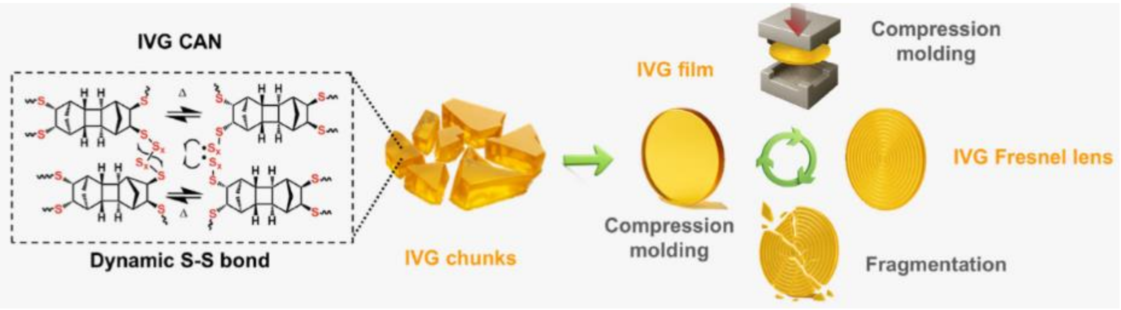
## Research Details

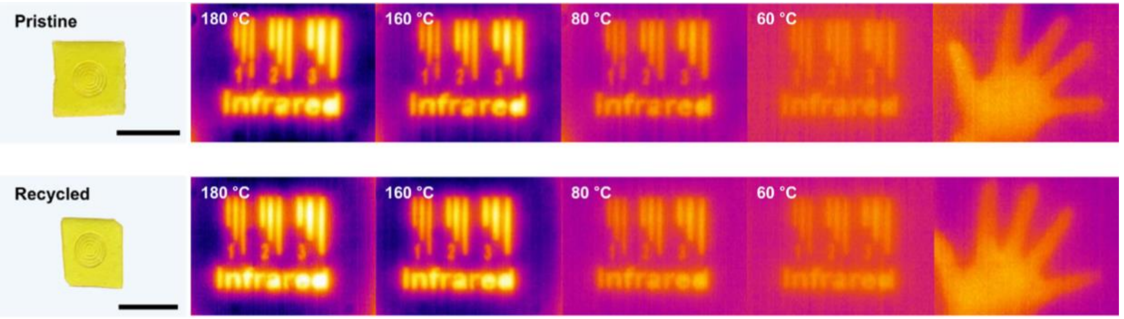
- Homogeneous sulfur melts enabled transparent inverse vulcanized glass containing up to 80 wt% sulfur, with a high refractive index, broad visible–infrared transparency, and excellent moldability.
- Dynamic S–S networks allowed repeated melt reprocessing while preserving optical and mechanical performance.
- DFT and MD simulations identified branched sulfur-rich networks responsible for the material's thermal stability and rheological behavior.

## Scientific Achievement

- Sulfur (70–80 wt%) was polymerized with norbornadiene dimer ($NBD_2$) through bulk inverse vulcanization.
- Melt processability and recyclability were evaluated through repeated fragmentation–compression molding cycles.




Holmen, L. N. et al. Adv. Mater. (2026); DOI: 10.1002/adma.73391

# Closed-loop workflow of high-entropy materials discovery: efficient and accurate synthesizability prediction via domain-specific local LLMs

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## Significance and Impact

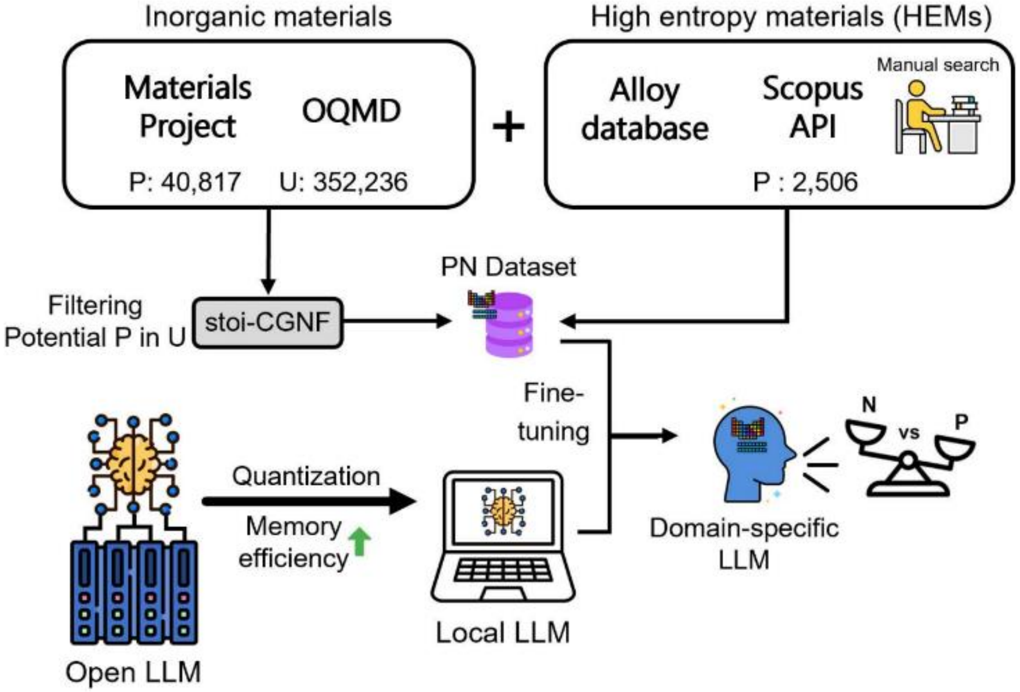
- Demonstrates a practical pathway toward autonomous closed-loop materials discovery using locally deployable AI models.
- Enables cost-effective, privacy-preserving, and reproducible HEM screening without reliance on commercial APIs.
- Highlights the importance of integrating failed synthesis data into collaborative open-data ecosystems for continuous model improvement.

## Research Details

- Domain-specific fine-tuning dramatically improved prediction performance, achieving MCC values up to ~0.88 and Precision >0.85.
- Fine-tuned local LLMs significantly outperformed commercial LLMs and conventional ML models in discriminative capability.
- The quantized models operated efficiently on accessible hardware while maintaining high predictive accuracy and reproducibility.

## Scientific Achievement

- Constructed a large Positive–Negative dataset containing 364,373 inorganic compositions, including 2,506 experimentally verified HEMs.
- Applied PU-learning and stoi-CGNF filtering to generate reliable negative samples and reduce label noise.




Yoon, Y. et al. npj Comput. Mater. (2026); DOI: 10.1038/s41524-026-02092-z

# Upcycling Waste LDPE into Highly Crystalline Graphite

## Significance and Impact

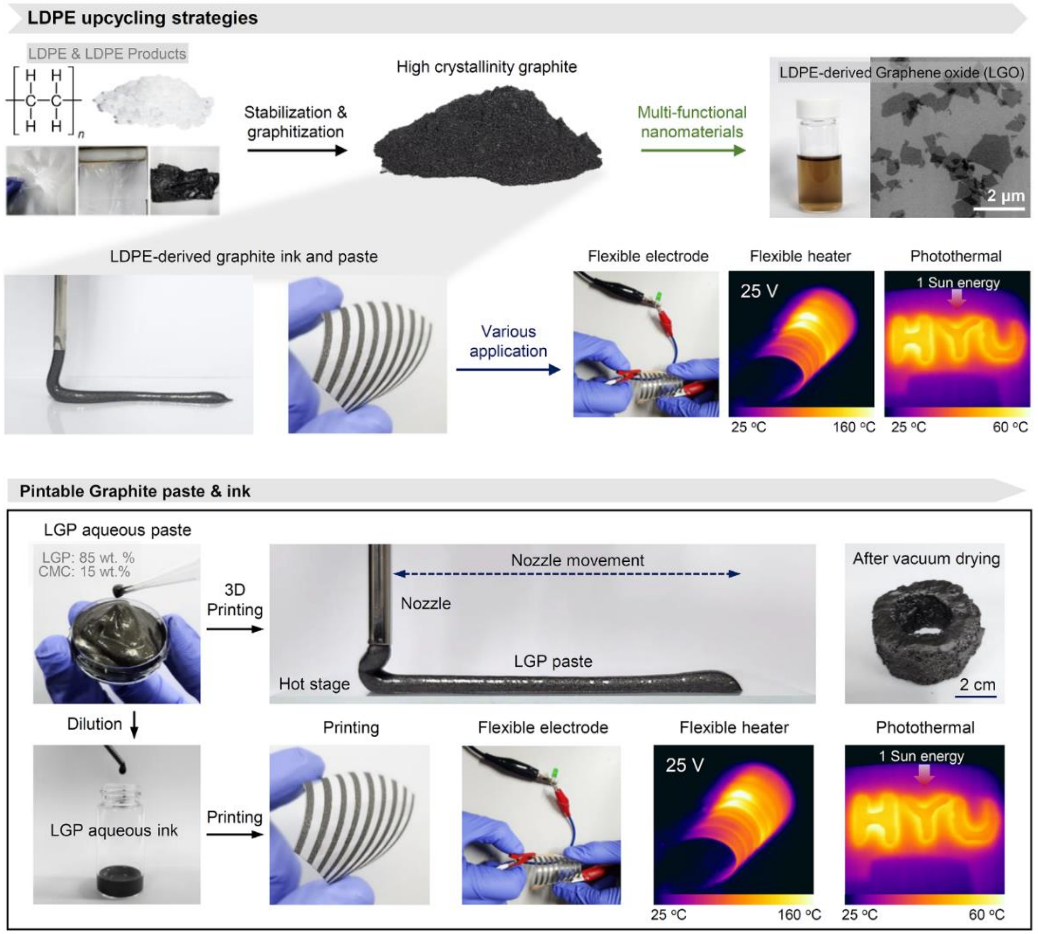
- Demonstrates a sustainable pathway for converting plastic waste into high-value carbon materials.
- Provides graphite materials suitable for flexible electronics, heaters, photothermal devices, 3D printing, and graphene oxide production.
- Suggests scalable opportunities for advanced energy and electronic material applications from recycled polymers.

## Research Details

- HN stabilization induced oxygen-functionalized cyclic ladder structures, significantly improving carbonization stability and carbon yield (up to 89.4%).
- Thermal annealing transformed disordered carbon into highly crystalline graphite with strong graphene layer alignment.
- Waste LDPE products also produced graphitic materials with conductivity comparable to or higher than natural graphite.

## Scientific Achievement

- LDPE and waste LDPE products (gloves, cling films, mulch films) were oxidatively stabilized using a hydrothermal nitric/hydrochloric acid (HN) process.
- Stabilized LDPE was carbonized and graphitized through high-temperature annealing up to 2700 °C under Ar atmosphere.




Jeong, W. et al. Adv. Sci. (2025); DOI: 10.1002/advs.202416978

# Design of Synthetic Microbial Coculture for Advanced Biomanufacturing of Lignocellulosic Biofuels and Bioproducts

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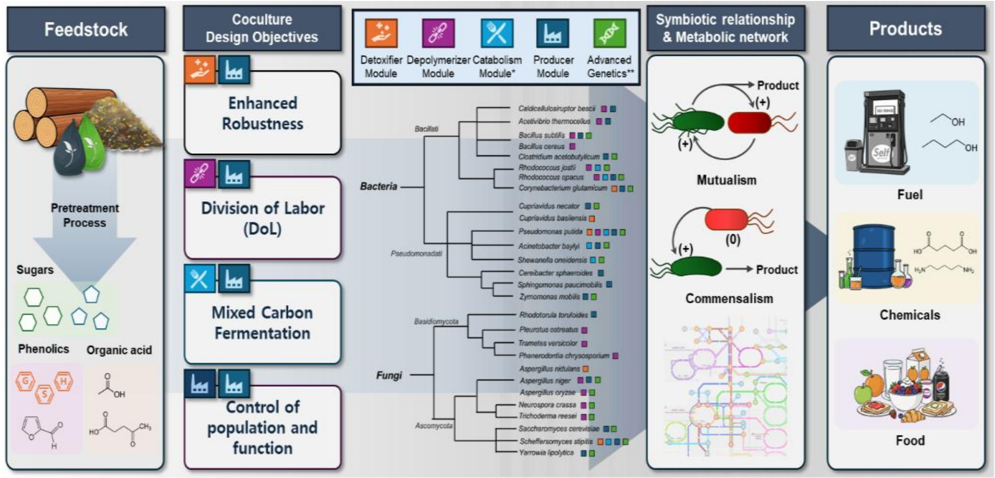


* Catabolize C6 or C5 sugars and phenolics
** Widely available CRISPR genome editing tools

***Green chemistry* 2026, Accepted**

Hyun-Joong Kim, Yoonmi Choi, Jiwoo Han, Ja Kyong Ko *, Hyun-Seob Song *, Hyeongmin Seo *

## Scientific Achievement

This tutorial review presents a systematic framework for objective-oriented microbial coculture design, aligning four core design principles with upstream pretreatment, downstream process configurations, and advanced synthetic biology tools to enable sustainable lignocellulosic biomanufacturing. It is among the few reviews to emphasize the role of microbial coculture engineering in greener chemical production, while highlighting key directions for future research.

## Significance and Impact

This paper presents synthetic coculture strategies tailored to diverse design objectives, introduces cutting-edge tools for constructing microbial communities, and integrates essential sustainability metrics for coculture-based processes. Critical future research directions are discussed based on the comprehensive research reviews: 1) Strategies to improve long-term stability of microbial cells; 2) on-line and in-line analytical technologies for precision coculture fermentation; and 3) comprehensive techno-economic analysis (TEA) and life-cycle assessment (LCA) of microbial coculture-based lignocellulosic bioprocessing.

## Research Details

- Distribution of complex bioprocessing tasks, such as lignocellulose depolymerization, inhibitor detoxification, mixed-sugar utilization, and product formation, effectively alleviates cellular metabolic burden and improves total substrate coverage.
- Systematic organization of existing synthetic coculture studies into structured reference tables provided a comprehensive database of strain combinations and processes parameters aligned with distinct design objectives.
- Providing future perspectives that the integration of advanced computational modeling (e.g., BioCADi) and synthetic genetic circuits will enable smarter coculture design and precision fermentation.

# Development of an efficient poly(3-hydroxybutyrate) production platform from lignocellulosic hydrolysates using a robust *Cupriavidus necator* RXI22 strain

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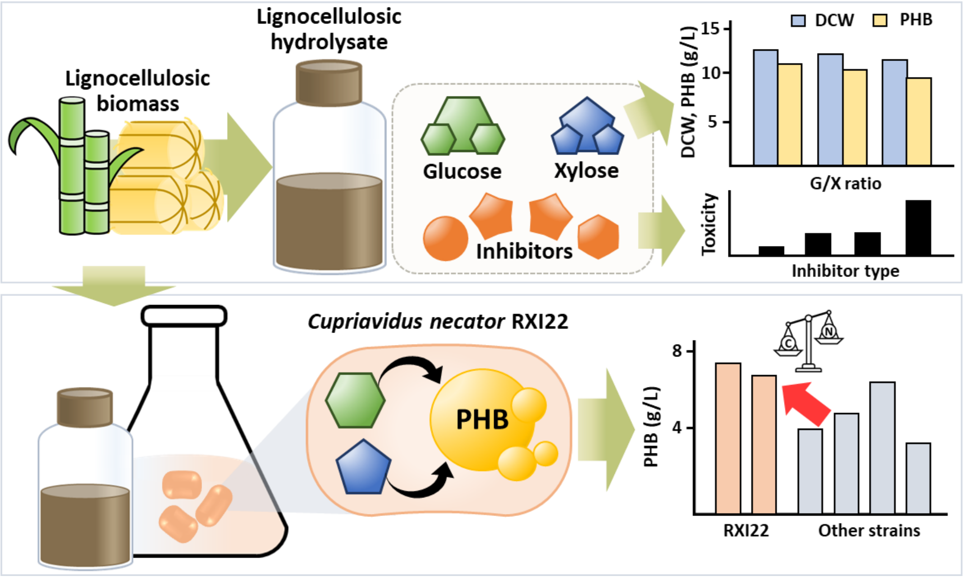


***Green Chemistry*** **(2026) 28(24): 10106–10118**

Habin Sun, So Jeong Lee, Hyun-Joong Kim, Hyeongmin Seo, Jeongchan Lee, Jung Ho Ahn, Gyeongtaek Gong, Youngsoon Um, Kyoung Heon Kim, Ja Kyong Ko*

## Scientific Achievement

- Established engineered *C. necator* RXI22 as a versatile platform for simultaneous glucose-xylose fermentation.
- Enabled high-yield poly(3-hydroxybutyrate) (PHB) synthesis directly from variable, inhibitor-rich lignocellulosic hydrolysates.

## Significance and Impact

A robust *C. necator* RXI22 platform enabled efficient PHB production across diverse glucose-xylose ratios directly from sugarcane bagasse and rice straw hydrolysates, achieving high performance under comparable conditions. Systematic profiling identified phenolic compounds as the primary bottleneck, while a novel nutrient drop-in strategy mitigated inhibitor stress – providing critical insights for future strain engineering and sustainable biorefinery development.

## Research Details

- Maintained high PHB production across a wide range of glucose-xylose ratios, achieving up to 10.1 g/L PHB and 0.46 g/g yield.
- Enabled direct PHB production from lignocellulosic hydrolysates without intensive detoxifications, yielding 6.1-7.0 g/L (~0.3 g/g).
- Systematically profiled biomass-derived inhibitors, identifying phenolics (e.g., ferulic acid) as key bottlenecks and mitigating stress via a nutrient drop-in strategy.