UNIVERSITY OF ALBERTA
TECHNOLOGY TRANSFER SERVICES

Renewable Polyurethane from Depolymerized Lignin: Catalyst-Free, Chemically Recyclable, and Shape-Adaptive

ID# 2025-085

HIGHLIGHTS

- **Decarbonizing Polyurethane**: A high-performance route that replaces fossil precursors with depolymerized lignin, sharply lowering the carbon footprint of industrial polymers.
- **Next-Gen Material Performance**: Catalyst-free lignin-PU achieving 69.1 MPa tensile strength, 1.7× higher than petroleum-based PU.
- **Circular Economy Integration**: Converts rigid PU thermosets into recyclable materials with high-tenacity adhesion to steel and wood.

OPPORTUNITY

Lignin is the world's most abundant renewable source of aromatics, yet 95% of industrial lignin is currently discarded or burned as low-value fuel. The barrier to commercial adoption has been lignin's molecular weight and structural recalcitrance, which typically results in brittle, low-quality materials when used as a chemical precursor.

Researchers at the University of Alberta have solved this by developing a modular depolymerization process. By utilizing moderate conditions and microwave heating, the technology deconstructs Kraft lignin into low-molecular-weight oligomeric bio-oil (BO). This refined feedstock overcomes traditional steric hindrance, allowing for significantly higher polyol loading in polyurethane formulations. The resulting bio-composite does not just replace petroleum; it outperforms it. The integrated BO enhances thermal stability and introduces a robust, thermally-triggered shape memory effect (achieving >90% recovery over multiple cycles).

Shape memory performance of PU

COMPETITIVE ADVANTAGE

- **Cost-Effective Scalability**: Optimized for mild reaction conditions and high-yield outputs, maximizing the value of a previously "worthless" waste stream.
- **Advanced Functional Properties:** 100% shape-fixity thermal memory and enhanced antioxidant performance without toxic organotin catalysts.

STATUS

- Patent pending.
- Camas KL, Sotelo Guzman CA, Upadhyay P, Rahman SS, Ullah A. Catalyst-Free Renewable Polyurethane Based on Depolymerized Lignin with Excellent Shape Memory Performance and Reprocessability. ACS Applied Polymer Materials. 2025 Sep 24.

INVENTORS

- Aman Ullah, Karen Lopez Camas

MORE INFORMATION

Joanna Preston, Director
Technology Transfer Services, University of Alberta
780.265.1075, jpreston@ualberta.ca