MWP – Young Researcher Abstract 2026

Project title:
Chemically Homogeneous Lignin for Bio-Based Thermosets and Beyond

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Abstract:

Lignin is the most abundant renewable aromatic polymer generated by the forest and pulp industries, yet most industrial lignin is still burned for energy instead of being transformed into high-value sustainable materials. One major limitation is its intrinsic chemical heterogeneity, which leads to poor processability and inconsistent material performance.

My research focuses on developing scalable strategies to convert lignin into chemically homogeneous and highly reactive building blocks for bio-based materials. Using a greener hydroxyethylation approach based on ethylene carbonate, lignin hydroxyl groups are transformed into more uniform aliphatic functionalities, significantly improving reactivity, processability, and material tunability.

The developed process has already been successfully scaled from gram to larger laboratory scales while maintaining structural consistency and thermal performance, demonstrating promising industrial potential. Importantly, the chemically homogeneous lignin also shows significantly improved material-forming ability compared to raw kraft lignin, enabling the formation of uniform thermoset materials. The resulting homogeneous lignin is currently being explored for bio-based thermosets and polymer network applications.

Through this work, I aim to support the transition from low-value lignin combustion toward scalable, high-performance sustainable materials for a more circular forest-based industry.

Keywords:
Lignin; Chemical homogeneity; Hydroxyethylation; Polymer networks; Bio-based thermosets; Sustainable materials.