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Abstract title

Understanding Biomass Structure for Designing Carbon-Based Catalysts in Sustainable Environmental Catalysis

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ABSTRACT

Converting biomass into carbon-based catalysts provides a sustainable and low-cost route for environmental remediation, especially in advanced oxidation processes like Fenton-like reactions. While biomass-derived carbon materials has been widely studied, the influence of the original structure and shape of biomass on carbon properties and catalytic remain unexplored. In this study, we explore how the native morphology of plant biomass, classified as two-dimensional (2D) flaky or one-dimensional (1D) acicular, affects the formation and activity of carbon and cobalt-carbon catalysts for peroxymonosulfate (PMS) activation. We found that 1D acicular biomass precursors promote the formation of tubular N-doped carbon structures with low surface C=O content, which enhances the selective electron-transfer pathway (ETP) for pollutant removal in PMS activation. In contrast, 2D flaky biomasses are more favorable for incorporating Co nanoparticles into the carbon matrix, leading to sulfate radical ($SO_4{\bullet}^-$)-dominated oxidation during PMS activation. Through systematic material characterization, including surface area, carbon structure (sp^2/sp^3), N and O functionalities, and cobalt loading, and linear fitting analysis, we reveal how specific material features influence catalytic activity and selectivity. Our findings demonstrate that the type and shape of biomass can direct the PMS activation pathway toward either non-radical ETP or radical-based mechanisms. This study provides a practical framework for using biomass morphology as a design parameter to tune the structure and function of carbon-based catalysts. By bridging the gap between natural biomass features and catalytic behavior, we offer insights for developing highly efficient and selective catalysts for water purification and environmental protection..

KEY WORDS

Biomass conversion, Environmental remediation, structure activity relationship

BIOGRAPHY

Include a short biographical (100 words) for the presenting author

Dr. Wenjie Tian is a Future Making Fellow at the School of Chemical Engineering, The University of Adelaide, Australia. She was previously awarded an ARC DECRA Fellowship (2022–2025). She received her Ph.D. in Chemical Engineering from Curtin University in 2018. Her research focuses on the design and synthesis of nanomaterials with controlled structures for environmental remediation and energy conversion, aiming to deliver sustainable solutions through advanced materials engineering.

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