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次世代型 PET 化学リサイクルに向けた CO_2 統合プロセスの設計

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Design of CO_2-integrated processes for next-generation chemical recycling of PET

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研究概要

Plastics such as polyethylene terephthalate (PET) offer excellent performance to improve efficiency in daily life, but their accumulation has become a serious environmental concern. Developing effective strategies to address this “white pollution” is therefore an urgent challenge. Conventional waste-management approaches rely heavily on thermal and electrical energy, producing CO_2 as a major “black pollution” byproduct. Given the rapid rise in atmospheric CO_2 levels, expanding its utilization is essential for achieving net-zero emissions. A process that valorizes both PET waste and CO_2 simultaneously presents a promising solution aligned with carbon-neutrality and plastic-recycling policies.

Our research focuses on developing reaction systems that utilize CO_2 for the efficient degradation of PET. Because PET depolymerization is reversible, shifting the reaction equilibrium toward the products is crucial. Transesterification can proceed effectively in the presence of a trapping agent that captures the byproduct, thereby driving the reaction forward. CO_2 plays a key role by enabling the in-situ formation of this trapping agent.

This study aims to design an effective catalyst capable of activating CO_2 to cleave the C–O bond in the ester moiety of PET. Using CO_2 in catalytic PET degradation provides a dual benefit: mitigating plastic pollution while converting CO_2 into valuable materials, offering a pathway to next-generation chemical recycling. With an estimated recycling efficiency of at least 70% , depolymerizing 1 kg of PET could potentially consume approximately 160 g of CO_2 (equivalent to ~81.3 L), demonstrating significant potential for combined waste valorization.