A green polyester and products from carbon dioxide, water and solar power

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Statement of the Problem: Carbon dioxide (CO_2) is a prime green-house gas emission from industrial processes. It can be converted into bio-oil and bio-diesel through conventional photosynthesis of microalgae. e CO_2 xation rate, however, is quite low and a ected by the intermittent solar irradiation.

Methodology & eoretical Orientation: An arti cial photosynthetic bioprocess is developed to produce green polyester from CO_2, water and solar power. In this green process, solar energy is captured using photovoltaic modules and converted into hydrogen as a stable energy source via water electrolysis. e solar hydrogen and oxygen is used to x CO_2 by a hydrogen-oxidizing bacterium.

Findings: Under the autotrophic growth conditions, CO^2 was reduced to biomass at 0.8 g L^{-1} hr^{-1}, about 10 times faster than that of the typical bio-oil-producing microalgae (*Neochloris Oleoabundans*) under indoor conditions. A large portion of the reduced carbon is stored in polyhydroxybutyrate (PHB), accounting for 50-60% of dry cell mass. PHB is a biodegradable thermoplastic that can nd various environmentally friendly applications. e green polyester can also be converted into small chemicals (C3-C4) with di erent functional groups. Speci cally, PHB is degraded and deoxygenated on a solid phosphoric acid catalyst, generating a hydrocarbon oil (C6-C18) from which a gasoline-grade fuel (77 wt% oil) and a biodiesel-grade fuel (23 wt% oil) are obtained via distillation. Aromatics and alkenes are the major compounds, depending on the reaction conditions. eir reaction mechanisms from crotonic acid, a major PHB degradation intermediate, are revealed and presented.

Conclusion & Signi cance: Biodegradable plastics and high-grade liquid fuels can be directly produced from carbon dioxide, water and solar power. e productivity of the green polyester (5.3 g L^{-1} d^{-1}) is much higher than that of microalgal oil (0.13 g L