sPET: Miniature Enzyme From Metagenomic Mining for the Hydrolysis of Polyethylene Terephthalate (PET)

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Polyethylene terephthalate (PET) plays a pivotal role in modern packaging and textile industries, contributing to over 350 million tons of global production annually. Despite its widespread use, PET's resistance to degradation poses a significant threat to environmental sustainability. The inefficacy of current recycling techniques, with high operational cost and pollution, emphasizes the need for innovative solutions. The studies explore the potential of PET hydrolase enzymes, which offer a promising solution as they facilitate the biodegradation process without causing harm to the environment or relying on hazardous chemicals. However, existing PET hydrolases struggle with the high crystallinity of PET plastics and require substantial energy for effective degradation, rendering them difficult for use in industrial applications. Our research aims to identify smaller enzymes capable of functioning at around ambient temperature to enhance cost-efficiency, operational feasibility, and the degradation of crystalline regions in PET. The use of metagenomic mining and tertiary structure analysis has facilitated the selection of enzyme candidates for cloning, expression, purification, and efficiency testing. sPET, the discovered enzyme, was capable of efficiently digesting PET films at 37 °C, and it possesses a high denaturation midpoint of 65 °C. This characteristic suggests sPET can be used over extended periods for the enzymatic recycling of PET monomers. Furthermore, our research introduces strategies to improve the degradation capabilities of the enzyme through the engineering of residues. These findings illuminate a path for the real-world integration of such enzymes, offering a practical and sustainable solution to the pressing challenge of plastic waste management.

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