Fabrication of Thermally Stable Enzyme Complexes for Enhanced Polymer Biodegradation and Their Application in Melt Extrusion Processes

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The growing accumulation of plastic waste, particularly microplastics, has intensified the demand for environmentally sustainable recycling technologies.[1] Enzymatic biological recycling presents a promising alternative, enabling polymer degradation under mild, non-toxic conditions with low energy input.[2] However, a major challenge remains in applying enzymes directly to conventional plastic manufacturing processes, such as melt extrusion, which involve high-temperature environments beyond the stability range of most enzymes.

In this study, a commercially available enzyme was immobilized through physical adsorption onto porous supports and entrapment within a polymeric matrix to enhance its thermal stability, enabling its application in polymer melt extrusion processes for improved biodegradability. The enzyme-immobilized composites were blended at a specific ratio into melt extrusion processes such as film casting and fiber spinning to fabricate biodegradable polymer films and fibers. The resulting materials exhibited significantly enhanced biodegradability, experimentally confirming that the enzyme retained its catalytic activity even under the high-temperature conditions of melt processing due to the immobilization.

Keywords: Enzyme Immobilization, Biodegradation, Biological Recycling, Melt Extrusion

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