

Biosourcing for Microbially Driven Polyethylene Degradation

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Background/Objectives. This project aims to discover and design novel methods and enzymatic pathways for bioconversion and reuse of synthetic polymers. Polyethylene (PE) is a synthetic polymer highly recalcitrant to degradation. The environmental and economic footprint of PE could be reduced through polymer biodegradation and upcycling technologies. Currently, little understanding on PE biological degradation exists and no direct enzymatic degradation pathway has been identified. Continued advancement in systems biology approaches, computational modeling, sequence-based homologue searching, and biosourcing allow us to elucidate the biological basis of PE degradation. Here, we investigate a natural capability of enriched microbial consortia to biodegrade and mineralize low density PE (LDPE) polymer.

Approach/Activities. This program integrates microbially driven processes that allow for degradation of thermostable polymers such as PE, and advanced molecular tools that shed light on exact reactions that take place in artificial microcosms. For degradation, the research concept involves elucidating of the biological catalyst(s) for degradation via gene and transcript analyses, and experimental laboratory testing of enzyme efficacy. Laboratory tests are performed on down-selected microbial enrichments and enzymes to determine degradation efficacy and parameters. These enzymes will then be engineered into a model organism for overexpression capable of degrading PE at higher rates.

Results/Lessons Learned. This work provides more information on microbial activities during the degradation of PE, which is difficult to biodegrade. Mass spectrometry analyses showed accumulation of hydrocarbon byproducts during after incubation of microbial consortia with LDPE. Current research has highlighted the challenges in enzymatically degrading highly crystalline structures of PE. Key risks include low yields of enzymes, high costs of genetic engineering of organisms, and difficulty in detecting and quantifying PE degradation.