

ADDRESSING THE PROBLEM OF PLASTIC WASTE: DEVELOPMENT OF AN ENZYMATIC PROCESS FOR PET RECYCLING

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Every day, media and NGOs describe the society's disaffection for plastics accused of polluting the planet. All major brand-owners made commitments to solve this problem (e.g. Coca-Cola, Nestlé, Danone, PepsiCo, Suntory, Unilever, L'Oréal, Nike) and announced a future with less plastic waste by 2025. Nevertheless, only 6 years before the announced term, no effective solution is yet available to meet these goals. Indeed, existing technologies like thermo-mechanical recycling leads to loss in mechanical properties of the polymer and even if several chemical recycling processes are under development, they suffer from the disadvantages of using organic solvents, high reaction temperatures and the need of an intensive waste sorting. Consequently, enzymatic recycling appears as a pertinent solution notably because the enzyme selectivity avoids a drastic sorting of waste and enables the recycling of complex plastics (multi-layers construction in some bottles of sparkling water for instance), it is an eco-friendly reaction in water and because of savings in energy consumption due to a low temperature of reaction.

Using a computer-aided engineering strategy, we drastically improved the depolymerizing performance of the best identified enzyme candidate. Utilizing site-directed mutagenesis targeted at the active site, combined with three-dimensional fold stabilization, we engineered an enzyme variant, demonstrating an astounding increase in thermostability combined with a high activity. This enzyme is able to depolymerize 90% of PET waste (200g/kg) into monomers, terephthalic acid and ethylene glycol, in less than 10 hours.

The downstream processing was developed and optimized leading to the demonstration that this enzymatic technology could enable the use of an industrial plastic waste to produce again PET monomers and ultimately a bottle from this recycled PET.

We hope to demonstrate the strong potential of the enzymatic technology jointly developed by CARBIOS and LISBP to provide a breakthrough solution to help solve society's growing plastic waste problem.