Thermally protected enzyme for degradable on-demand polymers

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Plastic accumulation in the environment has become a serious problem, and end-life strategies must be improved. An effective and eco-friendly approach to solve such problem is the use of biodegradable materials, whose global production capacities are set to increase from around 1.1 million tonnes in 2022 to approximately 3.5 million tonnes in 2027 [1]. In this sense, the use of polymer-degrading enzymes can be an efficient method for the management of plastic waste: indeed, new “degradable on-demand” materials could be produced, by embedding them in plastic formulation. However, efficient protection strategies for the enzymes are necessary, since the high temperatures required for most industrial plastic processes cause their denaturation and loss of their activity.
In the present study, cutinase from *Humicola Insolens*, selected as a highly degrading polyester hydrolytic enzyme [2], is immobilized in Mg/Al layered double hydroxide structures. The immobilization efficiency results high. After a specific trigger in an appropriate medium, the enzyme is released with no loss of activity. Moreover, its thermal stability strongly improves after immobilization, since its half-life at 90 °C increases by 6 times.
The immobilized cutinase is finally embedded in poly(butylene succinate-*co*-adipate) by melt blending and after triggering is able to completely degrade the polymer within 24 h.
The strategy here proposed suggests a solution to improve plastic circularity from origin to subsequent life cycles and could help to reach the ambitious targets pursued by recent European policies [3]. Indeed, these novel enzyme-containing polymers could be used in multilayer plastic packaging to tie different polymers, and at the end of life could allow delamination and recovery of the single layers.

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References

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