PETzyme: Towards a novel enzymatic immobilization strategy for biorecycling of plastic waste

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A. López Teijeiro[I], N. Barreiro Piñeiro[I], G. Eibes González[II], J.M. Martínez Costas[I]

[I]Centre for Research in Biological Chemistry and Molecular Materials (CiQUS), Rúa de Jenaro de la Fuente s/n, 15706, Santiago de Compostela (A Coruña), Spain, [II]Cross-disciplinary Research in Environmental Technologies, Rúa de Constantino Candeira, 3, 15705, Santiago de Compostela (A Coruña), Spain

The accumulation of plastic garbage in the environment has become one of the biggest challenges facing the world in the 21st century, with imminent consequences not only for wildlife but also for human well-being. Polyethylene terephthalate (PET) is the most abundant polyester plastic in the world, with an annual production of 70 million tons. However, less than 20% of PET is recycled, with most of the volume being released into landfills and oceans (Diao, J et al. (2023) Cell Reports, 42.1). Although mechanical and chemical recycling methods have been explored, their negative impact on the biosphere and the requirement for extreme operational conditions have limited their potential benefits. In response, enzyme-based plastic biodegradation has recently emerged as an eco-friendly and cost-effective strategy for managing PET waste. In this work, we propose the use of our own technology, the IC-Tagging system (Brandariz-Nuñez, A et al. (2010) PLoS One 5.11 e13961), as a new platform for the immobilization and stabilization of PET-degrading enzymes in order to overcome some of their constraints, such as efficiency, reusability or thermal stability. IC-Tagging allows us to load any enzyme of interest into protein nanospheres, maintaining its correct folding and catalytic activity. Our results demonstrate the capability of this method for the stabilization of active LCC-ICCG and *dura*PETase, two of the most promising enzymes for PET degradation. Immobilized enzymes are highly resistant to temperature and pH, and can be reuse up to 10 cycles without losing activity. Furthermore, both enzymes have proved to depolymerize PET beads to different monomers; particularly, LCC-ICCG lead to a weight loss of 30% in 70 hours. These results, in combination with the successful scale-up of the production of immobilized enzymes, lay the foundations for the use of IC-Tagging for recycling or upcycling PET residues to value-added products, contributing towards a circular plastic economy.