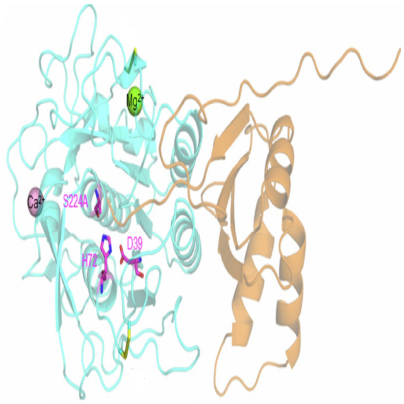
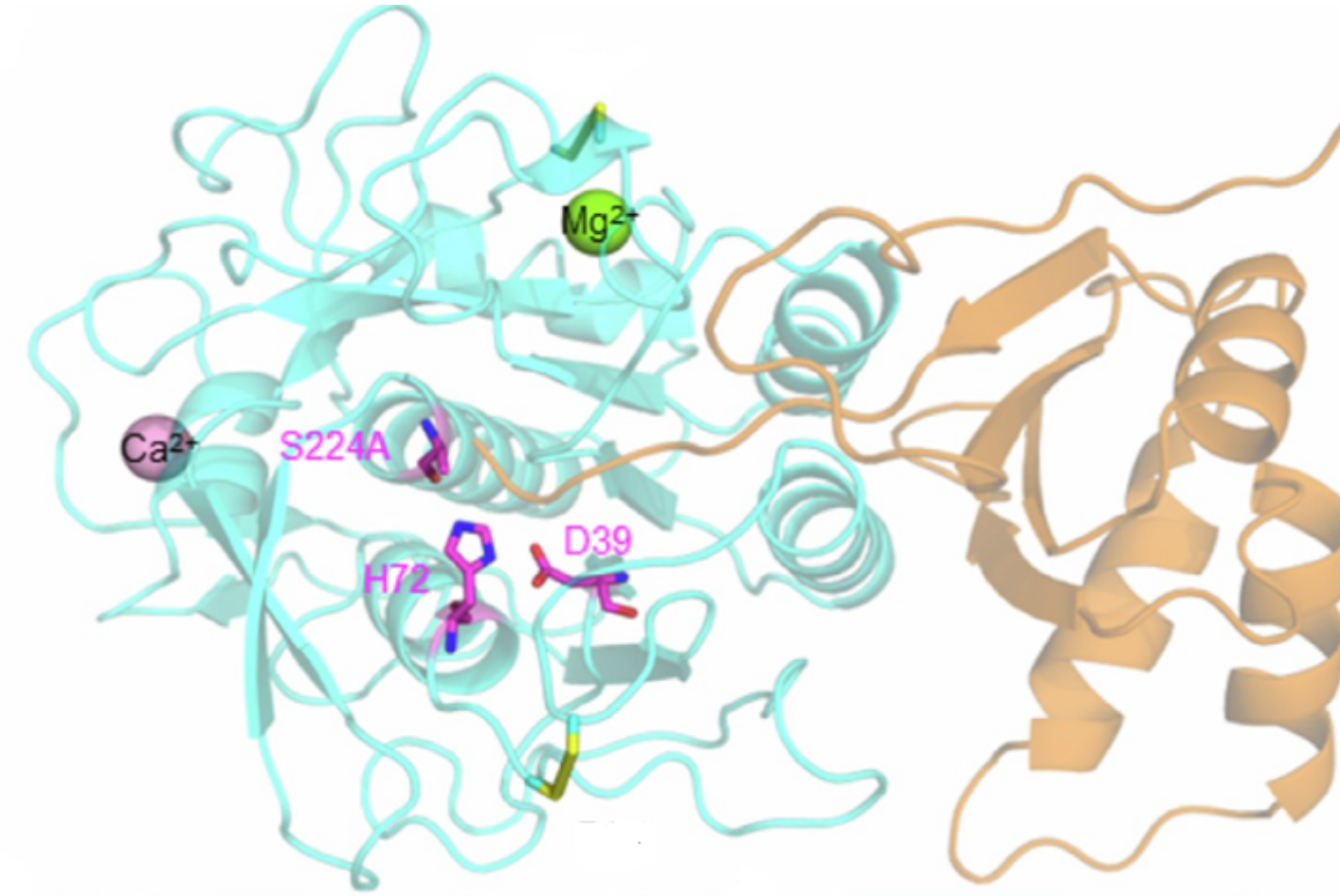


An Engineered Enzyme Embedded into PLA to Make Self-Biodegradable Plastic

Description

Plastic production reached 400 million tons in 2022, with packaging and single-use plastics accounting for a substantial amount. The resulting waste ends up in landfills, incineration or the environment, contributing to environmental pollution. Shifting to biodegradable and compostable plastics is increasingly considered an efficient waste-management alternative. Although polylactide (PLA) is the most widely used bio-sourced polymer, its biodegradation rate remains low under home compost and soil conditions. Using a scalable industrial process, the authors present a PLA-based plastic in which an optimized enzyme is embedded to ensure rapid biodegradation and compostability at room temperature. First, an 80-fold activity enhancement was achieved through structure-based rational engineering of a new hyper-thermostable PLA hydrolase. Second, the enzyme was uniformly dispersed within the PLA matrix using a masterbatch-based melt extrusion process. The liquid enzyme formulation was incorporated in polycaprolactone, a low-melting-temperature polymer, through melt extrusion at 70â??Â°C, forming an â??*enzymated*â?? polycaprolactone masterbatch. Masterbatch pellets were integrated into PLA by melt extrusion at 160â??Â°C, producing an *enzymated* PLA film (0.02% w/w enzyme) that entirely disintegrated under home-compost conditions within 20â??24â??weeks, meeting home-composting standards. The mechanical and degradation properties of the *enzymated* film were compatible with industrial packaging applications, and they remained intact during long-term storage. This innovative material opens new avenues for composters and biomethane production and provides a feasible industrial solution for PLA degradation.



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